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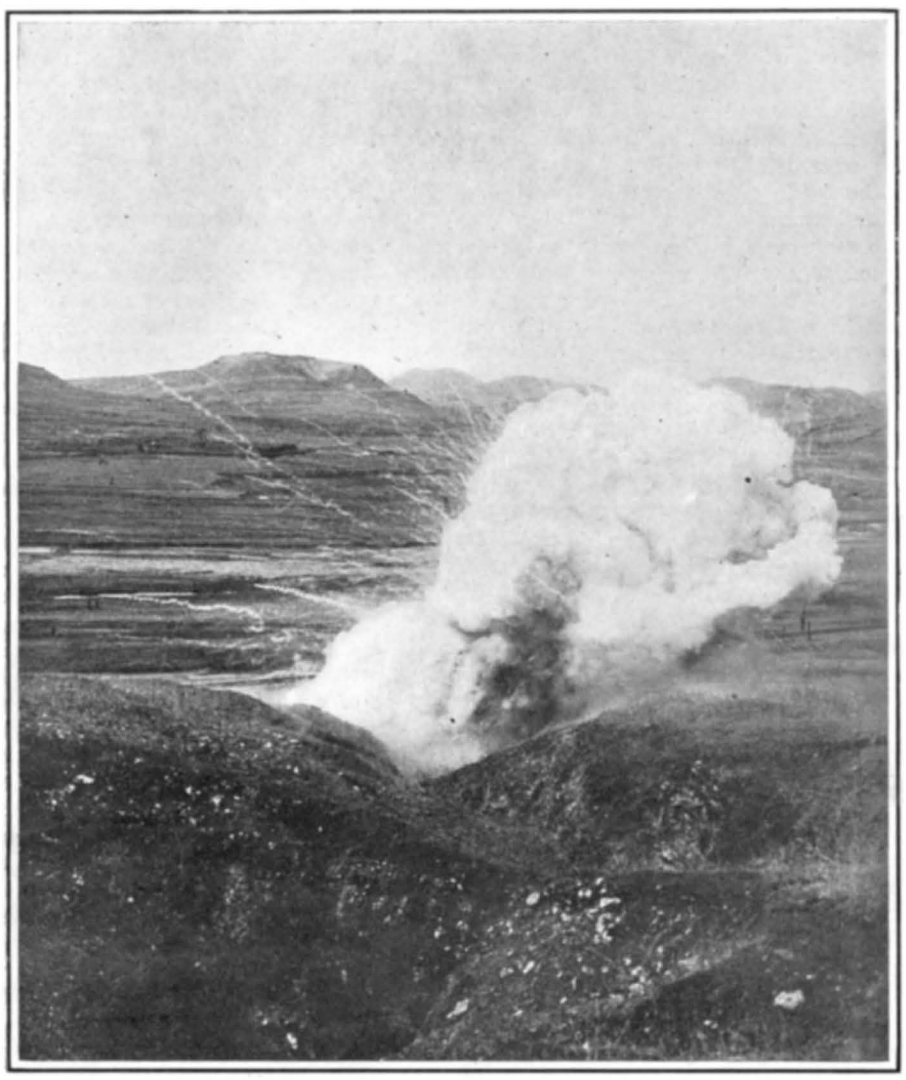
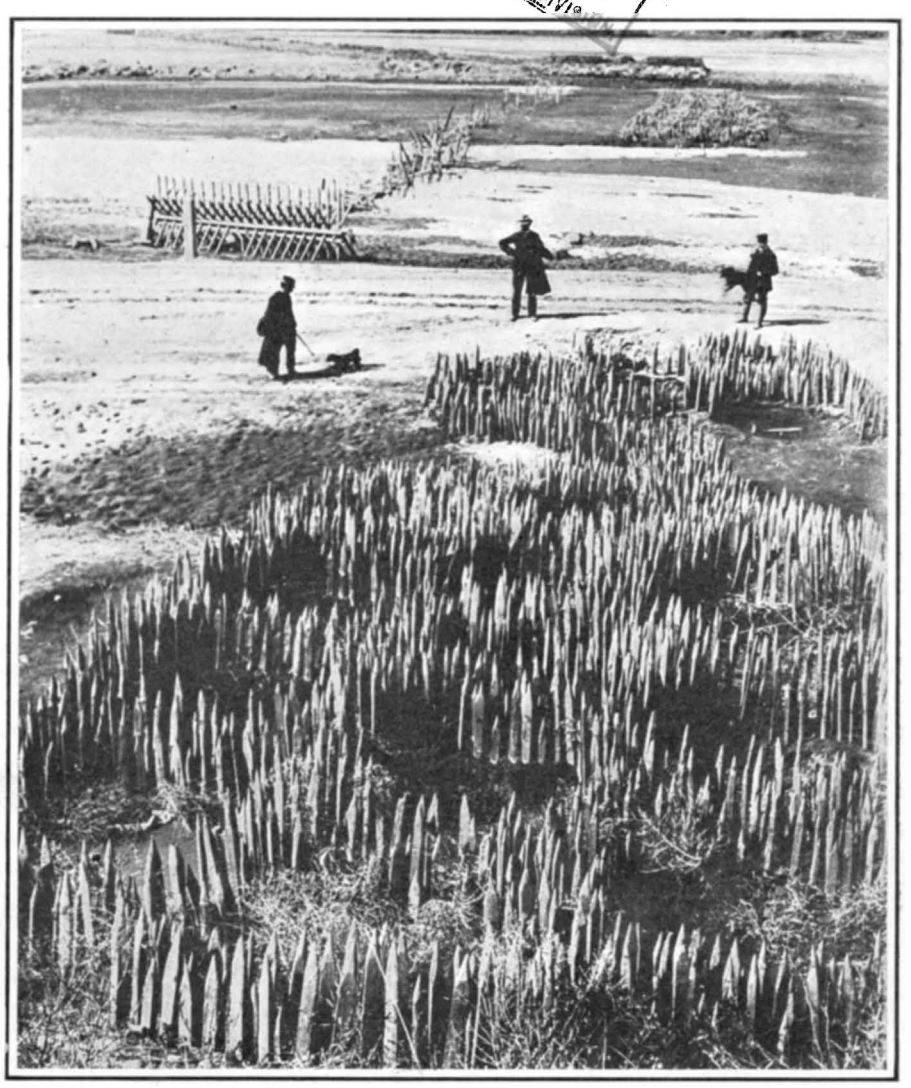


The camera has caught the flying fragments of the powder boxes and pieces of burning powder.

Explosion of a Mine on One of the Manchurian Battlefields.



Note the "wolf-holes" four feet deep, interspersed amid the forest of stakes.

Barriers Across One of the Main Roads into Port Arthur.

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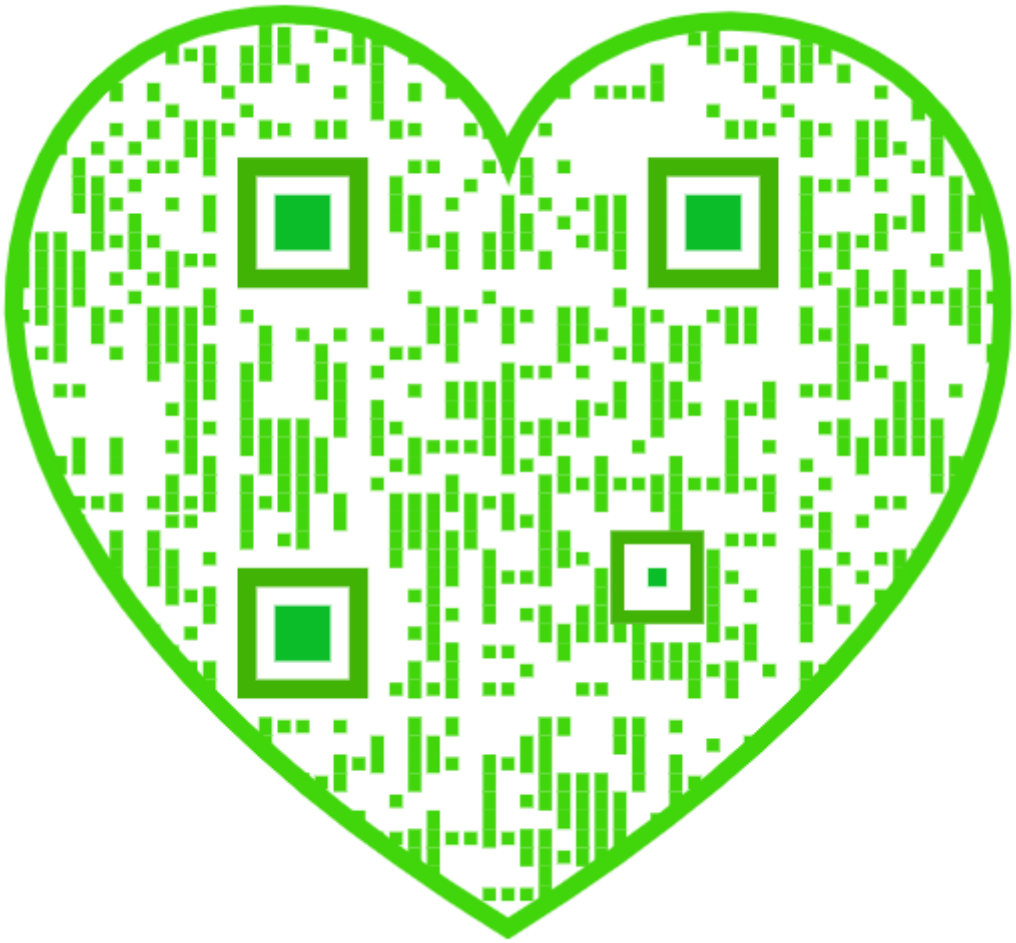
Snapshot of the Detonation of a Russian Mine, Containing 600 Pounds of Explosive, Near the Base of Nantezhan Fort, Port Arthur.

MINES AND ENTANGLEMENTS IN THE RUSSO-JAPANESE WAR.—[See page 482.]



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NEW YORK, SATURDAY, JUNE 17, 1905.

The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

THE EFFECT OF THE WAR ON NAVAL CONSTRUCTION.

Among the many surprises of the Japanese war is the fact that it is likely to produce but few changes in naval construction. So true is this, that the results may be taken as a triumphant vindication of the theories upon which the navies of the world have been built up.

When the full technical story of the struggle comes to be written, and the facts regarding the behavior of the war material have been collected, and the lessons deduced therefrom, naval constructors will, no doubt, see where they can improve on existing designs; but it is safe to say that the improvements will consist in modifications of a minor character. Already the fact is recognized that the present distribution of the total displacement of a navy among battleships, armored cruisers, protected cruisers or scouts, and torpedo boats, is about the best that can be made, and that each type of vessel is admirably adapted to the particular work which it has to do.

This result has the twofold effect of strengthening the confidence of the naval architect in his work and of giving a flat rebuke to the thousand-and-one naval cranks, who decry the big battleship and cruiser, and tell us that the torpedo boat and the submarine are destined to revolutionize naval construction, and sweep our big ships from the high seas. As a matter of fact, naval construction is a process, not of spasmodic revolution, but of steady and consistent evolution. By the strict law of the survival of the fittest has the battleship grown to its present huge proportions, and taken its place as the secure foundation upon which the whole structure of the navy is built up.

In the matter of details, however, there will be changes. The fleet action of August 10 (described in the SUPPLEMENT of December 31, 1904, and the SCIENTIFIC AMERICAN of March 11, 1905) was carried on, from the opening of the battle shortly after noon until 3 o'clock, at a range which was never less than six miles. In the second phase of the engagement the battle reopened at a range of four miles, and the distance between the ships was not reduced to two miles (which was hitherto supposed to be the probable battle range) until about an hour before the close of the fight. Now, at distances of from four to nine miles, at which last-named range, according to Capt. von Essen, the battle opened, only 10-inch and 12-inch guns can be used to any effect. Moreover, the greater the range the greater the advantage to the expert gunners; and hence it will be found that in the future the tendency will be to discard in our battleships, and to a less extent perhaps in our cruisers, any guns below a caliber of say 9.25 inches. Already, indeed, England is building two battleships which carry 9.2 guns in place of 6-inch guns in the secondary battery.

Armor, if of good quality, has proved wonderfully efficient, and, as far as we can learn, the cases of penetration of armor are very few. Probably we shall see in the future a disposition to reduce the thickness of the armor, and utilize the weight thus saved by increasing the armament. Or, if that be not done, the armor will be extended over a wider surface. It would be odd if we should come back to the type of the French "Dupuy de Lome," built some fifteen years ago, which was completely clothed with armor over the whole of the topsides and well down below the waterline. As a method of protection to the guns and crews, turrets are preferable to casemates. They have the objection that they are liable to become jammed by shell fragments; but this could be overcome by giving heavier protection in the wake of the turntable.

A serious problem that may well occupy the attention of our naval constructors is the protection of the uptakes and smokestacks. A high-explosive shell, bursting within a smokestack, tears it asunder, giving it the appearance of a burst steam pipe. When this happens, it is impossible to maintain steam in the boilers; speed is cut down; and the ship is at the mercy of her opponent. It is not unlikely that the practice which some navies have followed of armoring the base of the smokestacks, will be widely followed, and that the protection will be carried up to a greater height. This will be costly on displacement, and will have a serious effect on stability, but it will probably be done.

The torpedo boat has neither gained nor lost in reputation by the war, at least in the estimate of naval experts. It has done neither more nor less than they expected it to. Up to the Battle of the Sea of Japan not a single battleship had been sunk by a torpedo boat in action; and we shall have to await the arrival of authentic details to be sure that such a thing happened in Korea Straits.

The steering gear is another vital point which the searching fire of the Japanese has reached at times with disastrous effect. Several steering stations must be installed. In this connection, we are reminded of a portable electric steering wheel, which was described to the Editor by Lord Crawford during his recent visit. It consists of a circular disk with contact points, which may be carried to any part of the ship, even to the masthead if desired, and attached to electric cables which lead to the electric steering wheel. If, as in the case of the "Czarevitch" in the battle of August 10, the conning-tower steering gear becomes disabled, the portable gear can be carried to some other post on the ship, and immediately attached to the steering-gear wiring.

This duplication of parts might well be carried out with regard to other elements of control and direction, such for instance as the range finders. Both vertical and horizontal range lines should be established on every ship, and more than one of each, if possible. This is rendered necessary by the fact that the tendency, so common in this war, to overshoot, has resulted in the fighting tops or platforms on which the vertical range finders are established being swept by a storm of shell. To preserve the integrity of the range-finding apparatus should be one of the naval constructor's very first endeavors.

Finally, as a precaution against the formidable menace of mines, and the less formidable menace of the torpedo, something must certainly be done to more fully protect the flotation of the warship. The Germans have taken up this problem already, and are out with a design for a double-double bottom, one within the other. The idea is a good one, did it not make such inroads on the displacement. It will be necessary to adopt the double bottom, or go in for a greater subdivision of compartments. More numerous compartments would involve enormous inconvenience in the working of the ship, and would be costly in displacement. However, measures of some kind will have to be taken, for the very first desideratum in a fighting ship is that she shall float.

It can readily be seen that the modifications above mentioned all imply an increase in weight and size. Battleships, we venture to say, will in the future grow larger, not less, and they will unquestionably continue to be the most numerous and important type among the ships of the navy of the future.

FAST LONG-DISTANCE TRAINS.

The announcement by both the New York Central and the Pennsylvania systems that they are about to put on an eighteen-hour train to Chicago will bring to the public mind the fact that these two companies each placed in service two or three years ago a twenty-hour train between the same cities. The Pennsylvania Railroad system ran its train for some months, and after a checkered career it was taken off, for the ostensible reason that it interfered with other traffic. The New York Central train has continued in service, running with remarkable regularity. The Pennsylvania system has been spending large sums of money in reducing the heavy grades and sharp curvature on its mountain division, and the changes in location have led to a reduction of the total distance from Jersey City to Chicago to 904.4 miles. The total distance over the New York Central route is 959.15 miles, a difference of over 50 miles in favor of the Pennsylvania route. On the other hand, while the grades and curvature on the New York Central system are comparatively easy, those on the Pennsylvania route, especially where it passes through the mountains, are heavy and continuous.

Because of the longer distance traveled it is likely that the fastest speed over long distances will have to be maintained by the New York Central flyer, and that the credit of possessing the fastest long-distance train in the world will continue to belong to the latter system.

The question of the continuance of a fast service of this kind, is one for the public to decide. If these trains are well patronized, they will continue to run; and should the demand for this class of service become general, we may look to see not one but several eighteen-hour trains running between New York and Chicago. Both of these great railroad systems are well equipped for running these fast trains day by day with perfect regularity, and the practicability of such a service depends entirely upon the question as to whether it can be made to pay.

As to which train will give the steadier and smoother running, there can be no doubt that the New York Central, because of the absence of any mountain division, will be at a decided advantage.

In running over its mountain division the Pennsylvania flyer, if it is to be on time, will have to negotiate the curves at a speed for which no amount of super-elevation of the outer rail can fully compensate, and "rail-sickness" may claim its victims. Moreover, the three-tie suspension joint of the New York Central system, in which an extra tie is placed immediately beneath the joint, entirely removes that persistent "hammering" which is such an ever-present nuisance on some fast expresses.

VENTILATION OF THE SUBWAY.

During the construction of the New York Rapid Transit Subway, the SCIENTIFIC AMERICAN frequently drew attention to the fact that one of the most serious and difficult problems connected with the undertaking, was that of ventilation. At that time we contended that for the circulation and renewal of air within the tunnel something more would be required than the piston-like action of the trains, which the engineers believed would prove sufficient for the purpose. After the opening of the Subway we were agreeably surprised to find that, although a moving train filled only about one-fourth of the cross-sectional area of the four-track tunnel, it proved sufficient to produce strong currents, which caused a liberal inflow and outflow of air at the station entrances. Moreover, the renewal of the Subway atmosphere thus brought about was greatly assisted by the action of the easterly and westerly winds at the Subway entrances and exits, the strong downward current at the entrances facing the wind and the equally strong upward currents at the opposite entrances facing away from the wind, clearly proving that a very thorough circulation of air was taking place, at least at the stations. Nevertheless, now that the warm weather has come, it cannot be denied that the condition of the atmosphere in the Subway is very disappointing. That the oppressiveness is not altogether due to lack of circulation and renewal of the air, is proved by the fact that the air currents at the entrances and on the platforms are as strong in the warm as they were in the cold weather. Just what the unpleasant symptoms are due to is a question difficult to determine, but they are probably caused by the increased temperature acting upon the naturally humid atmosphere in the tunnel, and upon the odors due to exhalation from the enormous crowds that use the tunnel, especially at the rush hours.

Much of the discomfort is due to the fact that a refreshing drop in temperature on the street is not felt until some hours afterward in the Subway, and a person entering from the cooler outside atmosphere is apt to suppose that the heated air is an evidence of vitiated atmosphere. The problem of properly ventilating the system will be one of the most difficult yet undertaken by the engineer. Some relief may be obtained by installing a system of fans, but it would have to be put in upon a very costly scale before it would add materially to the renewal of air that is now taking place at the station entrances. It is of course unreasonable to expect that travelers in the Subway will enjoy as pure an atmosphere as that of the elevated system; but if the oppressive symptoms continue to increase as the midsummer heat comes on, some steps will certainly have to be taken to mitigate the nuisance.

THE SUBMARINE BOAT DISASTERS.

The recurrence of fatal explosions on board the English submarines, to say nothing of some of less fatal character that have occurred in our own and other navies, must go far to shake the faith of naval officers in this type of craft. The explosion referred to in our own navy happened when one of our boats was making a trip down to Southern waters. The submarine did not founder, but the injuries to the crew were serious. The trouble was attributed to the accumulation of explosive gases within the vessel. Later, in February last, a shocking disaster happened to the British submarine A5, which blew up off Queenstown, six of her crew being killed and twelve seriously injured. While a rescuing party were getting out the victims, a second explosion occurred, causing further injuries. And now there come from the other side the tidings of an accident of a similar character, but accompanied with a more terrible loss of life. While submarine A8, which is of the same type as A5, was engaged in practice outside Plymouth breakwater, three distinct explosions were heard, and the vessel, which seems to have been lying at the surface with hatches open, sank in several fathoms of water. According to telegraphic reports, the explosion could not have been fatal to all on board, as signals were made some time after she went down, stating that she was submerged and could not come to the surface. Subsequently to this there was evidence of another explosion, and all hope for the fourteen men that went down with her was abandoned. In this connection we are reminded that another British submarine, known as A1, was struck by a steamship while engaged in maneuvers last year, and sank with a loss of all her crew.

In the presence of these disasters, all of which have happened during peaceful maneuvers or practice, it will require some well-fortified evidence that the submarine has done effective work in the Sea of Japan, before our confidence in this new engine of war can be re-established.

SELECTION OF TRANSMISSION VOLTAGES.

BY ALTON D. ADAMS.

Electric transmission is now regularly carried on over distances up to 154 miles, the length of line between Electra power house and San Francisco, and with voltages up to at least 50,000, the pressure on the circuit between Shawinigan Falls and Montreal. From these superlative distances and electric pressures the line lengths and voltages drop gradually to the numerous transmissions of ten miles and less at not more than 10,000 volts.

Between the transmission over ten and that over 150 or 200 miles, there is evidently a wide range in choice of practicable voltage, though such choice should turn on well-defined engineering considerations. Like many other engineering problems whose solutions depend on various conflicting factors, the relation of voltage and distance has been differently fixed in actual transmissions. A broad survey of the majority of transmissions, long and short, will show, however, a fair approximation to a constant relation between voltage and distance, in a great number of cases. Such a relation once established on sound considerations, and illustrated by numerous examples, is obviously very convenient in the selection of a voltage for any particular case.

By the fundamental laws of electric circuits, it is known that the weight of conductors varies directly with the squares of their lengths, when the power transmitted, the voltage, and the loss are constant, and that the weight of conductors varies inversely as the square of the voltage, when the power, loss, and distance are constant. From these rules follows the one so often repeated in connection with transmission problems, that the weight of conductors remains the same with constant power and loss for all lengths of line, if the voltage is increased directly as the length. Attractive as this rule appears at first sight, it is probably safe to say that no group of transmission systems can be found that illustrate its application over a wide range of distances, say 10 to 150 miles. Certain it is that if any such group of transmissions can be found it will exhibit poor engineering in either the shorter or the longer lines.

A rule of which much less is heard, though its important illustrations in practice are far more numerous, may also be drawn from the two fundamental principles first stated. This rule is that with constant power and loss on the line, the cross section of conductors remains the same if the voltage of transmission varies directly as the square root of the length. If these relations are maintained, the weight of conductors obviously increases directly with the length of line, whereas with constant voltage the weight would increase as the square of the line length. The increase of voltage with the square root of the distance thus gives the line structure a constant cost per mile whatever the length.

It requires but a glance to show that a direct increase of voltage with distance, so as to hold the weight of conductors constant for a given power and loss, would soon carry line pressures beyond the limits of present practice. A voltage of 10,000 has been so generally and successfully used on transmissions under a great variety of climatic conditions, is so easily insulated, and adds so little to the dangers of much lower pressures, that it is very seldom too great for transmissions of five to ten miles. If 10,000 volts is adopted for a five-mile line, and a proportionate increase of pressure is made for a 100-mile line, the latter must operate at 200,000 volts, or about four times the greatest pressure now in use for power transmission. Even if a line ten miles long at 10,000 volts is taken as the starting point, a line of 100 miles requires 100,000 volts, if pressure and distance are to increase at an equal rate, and this voltage is nearly twice that in regular use for practical work. With 10,000 volts for a five-mile line, and an increase of pressure at the same rate as the square root of the distance, a line 100 miles long requires about 44,000, and a line 150 miles long about 55,000 volts, and these figures do not exceed present working limits.

Various factors combine to make the use of very high voltages on short lines undesirable. It is frequently the case with a line less than ten miles long, that a voltage of more than 10,000 or 15,000 would either render the conductors too weak mechanically, or raise their temperature too much, even with a small percentage of loss. The most that can be saved by the high voltage is some part of the weight of conductors, all of which is not great, and this is more than offset by the higher cost of insulators, larger crossarms and poles, and the greater risk.

Data of a number of the longer and more important transmission lines in the United States and Canada show that their voltages vary roughly as the square roots of their lengths, taking a five-mile line at 10,000 volts as a basis. Between Canon City and Cripple Creek, Colorado, a distance of 23 miles, the transmission line operates at 20,000 volts, while the voltage on the basis just named would be 21,000. A 23-mile line connects Niagara Falls and Buffalo, and its voltage is 22,000, or just above the figures reached by a rise with the square of the distance from five miles and 10,000 volts. The line from Apple River Falls to St. Paul is 24 miles long and its voltage is 25,000, while the voltage that would be employed on the basis named is 22,000. Spier Falls is about forty miles north of Albany, and the transmission line between these places has a voltage of about 30,000, while 28,000 volts is the figure based on five miles and 10,000 volts.

Santa Ana River develops electric energy that is transmitted at 33,000 volts to Los Angeles, 83 miles away. Allowing for a rise of voltage with the square of the distance, on the basis indicated, the line in this case would operate at 40,000 volts. Between Colgate power house and Oakland, California, the distance is 142 miles, and the line pressure based on 10,000 volts for five miles would be 53,000 volts. This transmission operated at 40,000 volts during several years, but the intention is to raise the pressure ultimately to 60,000 volts. On the 154-mile line between Electra and San Francisco the actual voltage is about 60,000, while an increase with the square root of the distance from five miles and 10,000 volts would give this transmission a voltage of 55,000.

In a few instances rather long transmissions are operated at materially higher voltages than those indicated by the foregoing considerations. Perhaps the most notable instance of this sort is the line between Canon Ferry and Butte, which is 65 miles long and carries energy at 50,000 volts. Even this case does not show a rise of pressure as the distance from five miles and 10,000 volts, for that would carry the voltage to 130,000.

It may or may not be that five miles and 10,000 volts are the most desirable figures to use as a basis, but some such basis having been reached, there will seldom be any good reason for using smaller conductors on a long than on a short transmission.

NEW METHOD OF MILK ANALYSIS BY CENTRIFUGAL APPARATUS.

A new method of making analyses of milk has been presented to the Academie des Sciences by Messrs. Bordas and Touplain. The process is claimed to be much more rapid as well as more exact than the methods which are now in use. With some of these methods only a part of the elements are determined. With others all the constituents are found and estimated, but the analysis often requires two days to carry out, and the caseine must be estimated by the method of differences on account of the uncertainty of the processes which are used. In the process which is given here the authors sought exactness as well as rapidity and simplicity of the operations, by employing centrifugal apparatus. Drop by drop, they introduce 10 cubic centimeters of the milk under analysis into a graduated glass tube containing a solution composed of 65 deg. alcohol acidified by acetic acid. The solution is allowed to rest for a few minutes and is then treated in the centrifugal apparatus. After decanting, the precipitate is washed by adding 30 cubic centimeters of 50 deg. alcohol. This is again placed in the centrifugal machine and then decanted. The liquids which are thus obtained are collected, and the lactose is estimated by Fehling's solution. The extraction of the butter is carried out with the precipitate which comes from the preceding operation. Two treatments are made with 2 cubic centimeters of 96 deg. alcohol for the first and 30 cubic centimeters of ordinary ether for the second. Each time the matter is treated in the centrifugal machine for a few minutes, and the ether is collected in a graduated vessel where it is evaporated and the butter is weighed after drying. In the tube of the centrifugal apparatus there only remains the caseine in fine powder, which is quickly dried at the ordinary temperature. It is weighed in the tube itself, the latter having a known weight. The above estimates are completed by finding the ash which is given by 10 cubic centimeters of milk. This method suppresses all the filtrations and partial solutions as well as the long and tedious process of drying the caseine. By using a single test specimen we can make all the estimates in the same tube by successive solutions and precipitations. Besides, only a small quantity of milk is needed to make an analysis.

AN EXPLANATION OF ICE CAVES.

In many parts of the world caves are found which contain ice all the year round, though the average annual temperature of the air in the caves is far above the freezing point.

Years ago B. Schwalbe suggested, supporting his hypothesis by still older (1865) experiments of Jungk, that the refrigeration in this case is due to percolation of water through porous strata. The physical justification of this assumption, however, has since been apparently destroyed by experiments, in which the percolation of water through silica and other powders was found to be attended by a rise of temperature, in some cases of considerable amount.

G. Schwalbe has now made a series of experiments with pure silica and different kinds of sand, using water of various initial temperatures, and has found that water warmer than 4 deg. C. (the temperature of maximum density) is heated, water cooler than 4 deg. C. is cooled, and water at 4 deg. C. is unchanged in temperature by its passage through the porous stratum. The maximum change in temperature, equivalent to a development of heat of 6.16 gramme-calories, was observed when 20 grammes of water at 16.3 deg. C. were allowed to percolate through 10 grammes of silica.

These results are in accordance with deductions from the mechanical theory of heat, and are due to the fluid pressure caused by the attraction exerted by a solid body upon the film of liquid which adheres to it. As water expands with rise of temperature above 4 deg. C., and also with fall of temperature below 4 deg. C., compression necessarily causes heating in the first case and cooling in the second.

THE CURRENT SUPPLEMENT.

In double-tracking a part of the Illinois Central Railroad, it was found necessary to build a more substantial bridge across the Big Muddy River at Carbondale, Ill., than the existing steel structure. In the opening article of the current SUPPLEMENT, No. 1537, the concrete bridge, which took the place of the old steel structure, is very fully described and excellently pictured. The Lister Two-Cycle Gas or Oil Engine is carefully described and illustrated. Recent developments in Wireless Telegraphy are reviewed. Mr. Charles A. Mudge's paper on High-Speed Long-Distance Electric Traction is concluded. The English correspondent of the SCIENTIFIC AMERICAN gives a *résumé* of an interesting lecture recently delivered before the Royal Geographical Society of Great Britain on the subject of Tibet. Sir William H. White's scholarly review of Submarines is concluded. The origin of the craters of the moon has baffled selenologists ever since the mountainous character of our satellite was first recognized by means of the telescope. It has been thought that perhaps the many craters of the moon, which number not less than 250,000, and perhaps 1,000,000, were formed by the impact of countless meteors. Mr. R. S. Tozer in the current SUPPLEMENT seeks to prove the truth of this theory by describing some experiments which he made, which consisted in hurling projectiles against plastic clay. Although his miniature craters bear a striking resemblance to those found in the moon, the Editor differs with this conception for reasons advanced in a brief note to Mr. Tozer's article. Mr. Rossi concludes his brief study of the Ferro Metals and their electrical manufacture.

LOSS OF HEAT IN STEAM.

M. Maréchal, engineer of the Association Normande des Propriétaires d'Appareils à Vapeur, who has carried on interesting investigations on the steam engine and the proportion of calories actually utilized, has arrived at the conclusion that, even with the most perfect systems, as much as 59 per cent of the total heat developed goes to the condenser. When the motor is of free escapement, 63.6 per cent of the heat is dissipated in the atmosphere.

A VAGARY OF THE RUSSIAN PRESS CENSOR.

In our issue of April 15, Mr. Lodian described the compressed tea which is used by the Siberians and by the Russian army in Manchuria. The article was accompanied by an illustration of a tablet of compressed tea, bearing the imprint of the Russian government. The printer was not familiar with the Russian language, for which reason the engraving appeared upside down, so that the insignia of the Czar upon the tablet were reversed. This revolutionary proceeding proved too much for the censor. In every copy of the SCIENTIFIC AMERICAN that reached our Russian subscribers the unfortunately placed engraving was ruthlessly blacked out.

The Chicago & Alton Railway has announced that it has made all arrangements for the establishment of a wireless telegraph system on all its trains running between Chicago and St. Louis, and that eventually all its trains will be in wireless telegraphic communication with the larger cities. The announcement was the result of careful tests made on a limited train running between Chicago and St. Louis. The observation car was equipped with the wireless apparatus. Messages were received while the train was running at a speed of fifty miles an hour. Mr. Felton, president of the road, announced that this was the first time the wireless system had ever been used to communicate with persons on a moving train. In this he was wrong, for if our memory serves us, similar experiments were carried out two years ago in Canada with marked success.

THE ALVARES AEROPLANE FLYING MACHINE.

BY THE ENGLISH CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

A new flying machine has been constructed upon the aeroplane principle. The apparatus is the invention of Senhor Alvares, of Brazil, and has been constructed under his supervision by Messrs. C. G. Spencer & Sons.

In this apparatus the designer has adopted the bird with wings outspread in the act of flight as his model. As will be gathered from the accompanying illustration, the machine consists essentially of two huge aeroplanes similar in shape to the wings of a bird outstretched in a swooping position. The framework is constructed throughout of bamboo, even including the body, thereby obtaining the maximum of strength with the minimum of weight, the various members being held taut in position by wires. The front members or ribs of the two wings terminate centrally and the aeroplane material is tightly secured thereto, and being triangular in shape, the two wings terminate in a point at the rear. The two wings measure 40 feet from tip to tip and the aeroplanes have a total superficial area of 400 square feet. In the forepart of the machine are placed two out-riggers. Each carries at its forward end a two-bladed propeller or tractor 5 feet in diameter, and having a speed of 240 revolutions per minute. These are driven by belting from a 2-horse-power single-cylinder vertical gasoline air-cooled motor with a speed varying up to 1,600 or more revolutions per minute. The motor is placed centrally in the machine, about level with the operator's head, though for purposes of easy control it is within convenient reach.

In the place of the tail are two horizontal rudders, controlled by guide ropes, and these perform the same function as the tail of a bird. By the manipulation of these rudders an upward or downward course is maintained while there is an additional fish-tail rudder for directing the machine to the right or left. The gas bag is entirely dispensed with, the lifting power of the apparatus being entirely dependent upon the aeroplanes combined with the power exerted by the tractors.

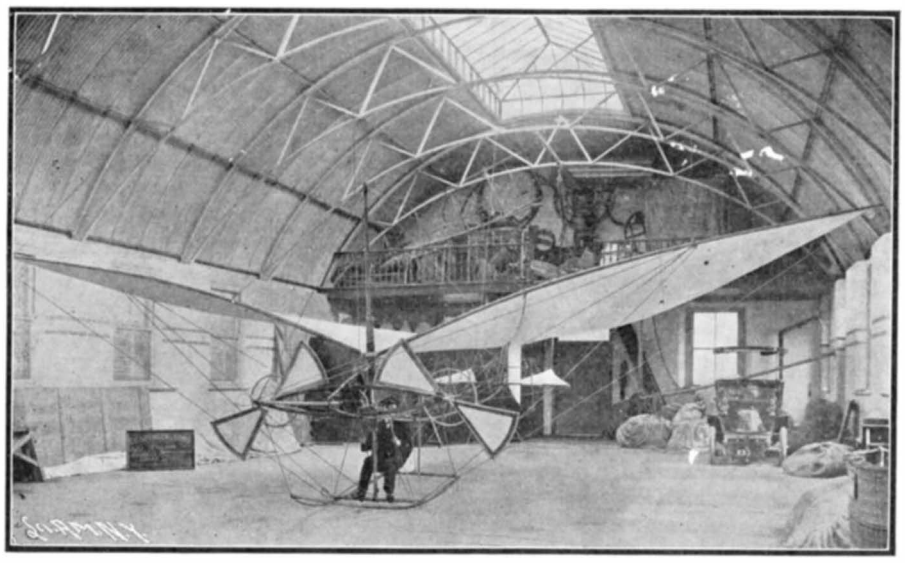
The aeronaut has a seat slung from the body of the apparatus in the fore part, and as near the estimated center of gravity as possible. Perfect control is assured by converging every controlling mechanism within the operator's reach. The aeroplane has a total lifting capacity of 150 pounds. The general design of the machine is symmetrical. The front ribs of the wings have graceful curves and they, as well as the body, taper gently away to the rear.

The machine cannot acquire sufficient impetus to enable it to lift itself from the ground. In order to test its flying capabilities, however, it was intended to attach the apparatus to a balloon and to carry it to an altitude of 5,000 feet. The gasoline motor was then to be set in motion, and, while running at full speed, the aeroplane was to be cast off. Instead of carrying a passenger, ballast equivalent to 150 pounds in weight was to be attached, placed in the position the aeronaut would occupy while standing upright. By these experiments valuable data respecting the center of gravity, balance, and general behavior of the machine would, it was hoped, be obtained.

The machine is not supposed to drop vertically or to glide in the same manner as the flying machines of Lilienthal and Pilcher, but to descend gradually in a series of aerial jumps, as it were. Gravity is the power-giving motion, the motor simply exercising an accelerating or retarding influence so that the curves will be of a great radius.

For the purposes of practically demonstrating the possibilities of this principle of aeroplane construction, an open tract of country was employed. The balloon used in connection with the trial was of 25,000 cubic feet capacity. The aeroplane was attached to the balloon and when an altitude of 3,000 feet was attained the motor was set in motion and the airship was cast adrift, its progress being followed both from the occupants in the car of the balloon, and a group of interested experts on the ground below.

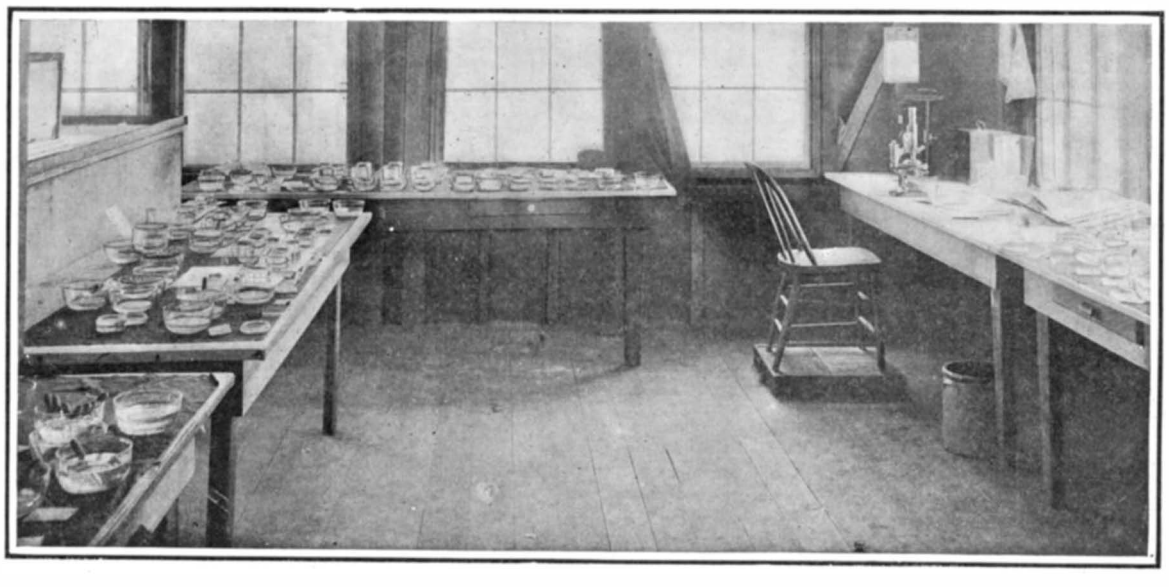
When the aeroplane was liberated it plunged rather erratically toward the earth for some distance. When it had regained its equilibrium, however, it sailed steadily in a horizontal direction. The propellers revolved rapidly and the aeroplane maintained its balance in a perfect manner. It traveled at a high speed for over a mile, and then came slowly and steadily to the ground as the power of the motor became exhausted. The experiment was attended with complete success, and testified to the efficiency of the design. A larger machine with a motor having sufficient power to lift the machine from the ground will soon be built.



THE ALVARES AEROPLANE FLYING MACHINE.

Composition for Cleaning Fabrics.—The mixture is formed of oil of turpentine, 264.80 grammes; ammonia, 190.20 grammes; methylic alcohol, 250.30 grammes; ether, 22.56 grammes; acetic acid, 22.50 grammes; water, 250.20 grammes.—Science Pratique.

PROF. JACQUES LOEB.



THE LABORATORY IN WHICH PROF. LOEB'S DISCOVERIES HAVE BEEN MADE.

THE CREATION OF LIFE BY ARTIFICIAL MEANS.

BY ENOS BROWN.

To create life and control its form at will is, confessedly, the ultimate objective of a school of physiologists of which Prof. Jacques Loeb, M. D., of the University of California, is conceded to be its most advanced, profound, and confident apostle. Startling as this announcement of the aspirations of the modern scientist may appear to the average thinker, it is based not upon metaphysical or academical speculations, but upon infinitely minute and long-continued experimentation and convincing demonstration. Evidence, which cannot be doubted, has been accumulated, evidence that shows how life can be created by purely chemical means.

Dr. Loeb was from 1892 to 1902 professor of physiology at the University of Chicago. Before coming to the United States he studied at the German universities of Berlin, Munich, and Strasburg. In 1902 he was called to the chair of physiology in the University of California and is now with that institution.

The conclusions of Dr. Loeb, after patient and continued investigations, are incorporated in his latest work, entitled "Studies in General Physiology," a decennial publication of the University of Chicago, 1905. It is a work of an epoch and only to be appreciated by the most advanced students. In these studies the author unequivocally asserts that it is possible to control life phenomena and that such control and nothing less is the true aim of the science of biology. In taking up the problem of regeneration the idea of controlling these phenomena was the starting point, the first aim being to find means by which one organ could, at will, be caused to grow in place of another organ. As far as the problem of fertilization is concerned, the first step toward its solution consists in an attempt to produce larvæ artificially from unfertilized eggs in various classes of animals.

After painstakingly exact and long-continued experimentation Prof. Loeb has succeeded in fertilizing and subsequently in developing eggs of the sea-urchin by employing artificial means alone. In the earlier experiments of Dr. Loeb artificial solutions were used instead of sea water. It has been found that the results were the same when sea water was used.

The most rigid precautions were taken to prevent fertilization by active cells of the same species. To destroy all germs effectually the sea water used was raised to a temperature of 140 deg. All tools, dishes, appliances, and the animals themselves which furnished the eggs, were cleansed in running fresh water. All other precautions were taken against the possibility of developing eggs without fertilization.

The processes by which these amazing results were obtained are stated in the bulletins issued from time to time by the University of California, in which are described the methods of fertilization and subsequent development of the eggs of animals which were the subject of experimentation. One method of treatment consisted in placing the eggs for about two hours in hypertonic sea water, in which the proportion of salt was somewhat increased, and afterward placing them for a few moments in normal sea water to which a minute quantity of ethyl acetate had been added, the eggs then taken from this mixture and placed in normal sea water, when membranes formed. Almost without exception each egg developed into swimming larvæ. With such simple means as a weak solution of vinegar acid and a strong solution of common salt the experimenter may duplicate in the laboratory the results of one of the most typically vital processes.

Chemical substances in skillful hands can be made to produce effects upon eggs which imitate, in all essential respects, the results of normal fertilization. Large numbers of larvæ of sea urchins, normal and healthy, may now be produced from the egg by purely chemical and physical means.

In this the scientist is able to imitate natural fertilization completely, and the fact that a large proportion of larvæ, thus raised, seem to have the same vitality as when produced in regular order

(*Continued on page 482.*)

THE NEW SUBMARINES FOR THE BRITISH NAVY.

Although the British Admiralty was for some time disposed to regard with little favor the attempts which were being made by other nations, notably by France and the United States, to develop a practical submarine torpedo boat, now that they have themselves commenced the construction of this type of vessel, they are pushing forward their experimental work with characteristic thoroughness and activity. The first vessels, introduced some three or four years ago, were of the Holland type, with which we are familiar in this country. An order for five submarines was placed with Vickers, Sons & Maxim, at Barrow. These vessels were practically identical with our own boats of the Holland type. They are 63.4 feet in length, 11.9 feet in diameter, and 120 tons displacement. They have engines of 160 horse-power, and have a speed of 9 knots on the surface and 7 knots submerged. The vessels were launched in from 1901 to 1902. Following these came the A class, five vessels 100 feet in length by 10 feet in beam, and of 180 tons displacement. With 150 horse-power they are credited with a surface speed of 15 knots, a speed of 9 knots submerged, and a radius of action of 300 miles. It is one of these that was lost on June 8. The next order was for ten boats of much greater size and power. They are 150 feet in length and 300 tons displacement. Their engines of 850 horse-power are designed to give them a speed of from 15 to 16 knots on the surface and from 9 to 10 knots submerged. These vessels have a radius of action of 500 miles. Under the programme of last year, ten submarines were ordered, but the particulars of these vessels have not yet been made public. The first Holland submarines and the vessels of the A class are driven by gasoline engines when they are on the surface, and by electric motors when they are submerged. In the B class the motive power is said to be entirely electric—a rumor which we very much doubt. Great improvements have been made in the diving gear, by which the boats are enabled to dive at very short notice. Under the older system, as used on the Holland boats, it took about three minutes for the vessel to dive. Moreover, it was necessary for the boat to keep in motion as long as it wished to remain submerged. The older boats cost about $150,000 each, and the B class cost about $650,000.

It will be noticed from the dimensions given above that the ratio of breadth to length is much smaller in the new boats than in the earlier Holland type. In the first case the ratio is about 12 to 64, or say 1 in 5 1-3; whereas in the A class it is 10 to 100, or 1 in 10, and probably something finer in the vessels of the B class. The finer lines of the new boat are very noticeable in the accompanying views, as is also the high freeboard and considerable deck space when the vessel is in the surface position. It is probable that we shall see in the future developments of the submarine an increase in proportions and size, similar to that which has taken place in the torpedo boat and torpedo-boat destroyer, which have developed from the little craft of less than 20 tons up to seagoing craft of 550 tons.

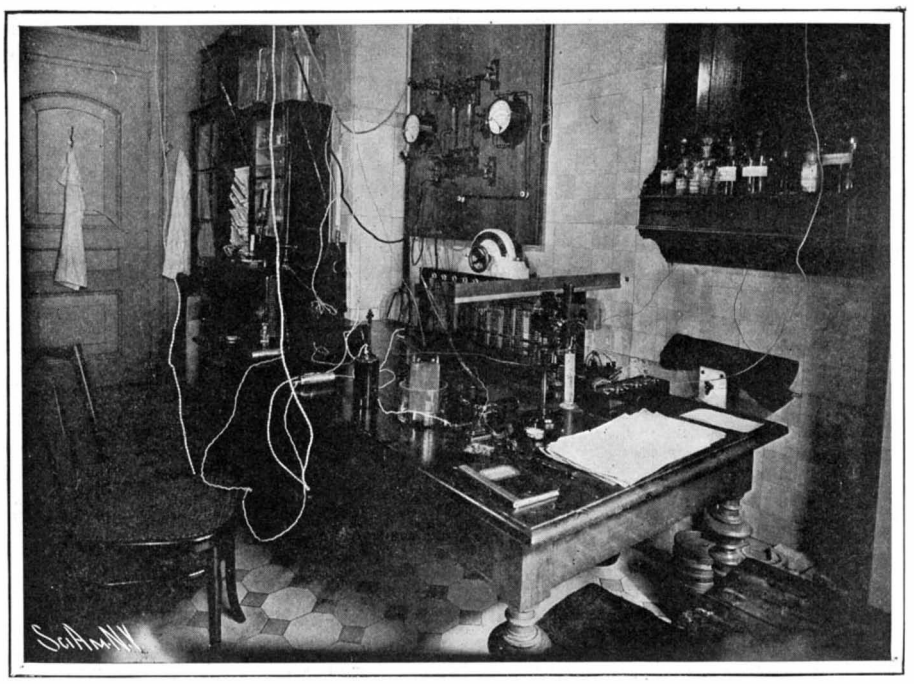


Fig. 1.—APPARATUS FOR MEASURING INDIVIDUAL RESISTANCE OF PATIENTS.

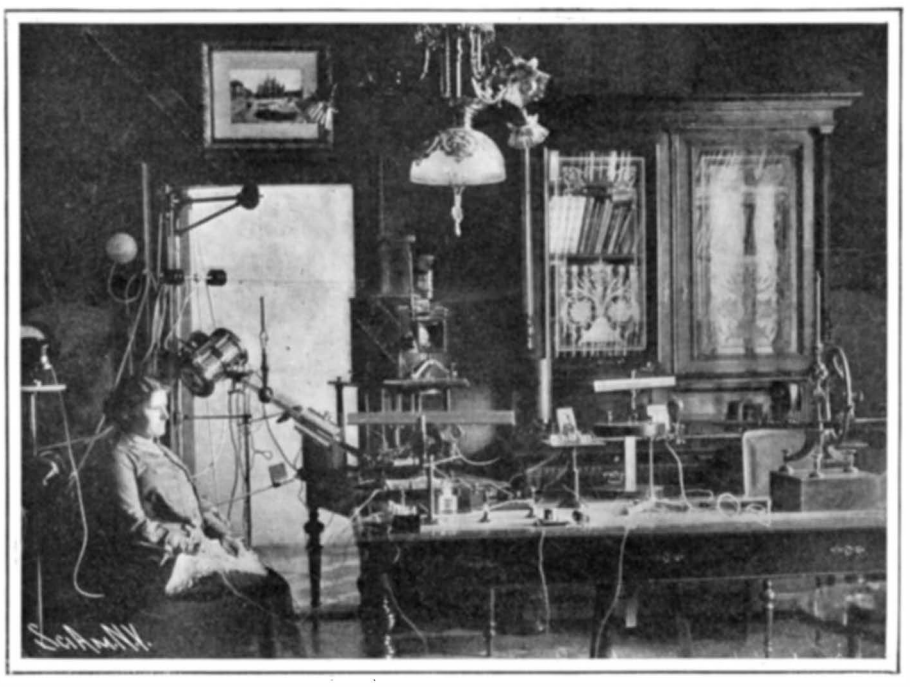


Fig. 2.—APPARATUS FOR CHECKING AN ELECTROMAGNETIC TREATMENT.

ON A PROCESS OF MEASURING NERVOUS SUSCEPTIBILITY.

BY DR. ALFRED GRADENWITZ.

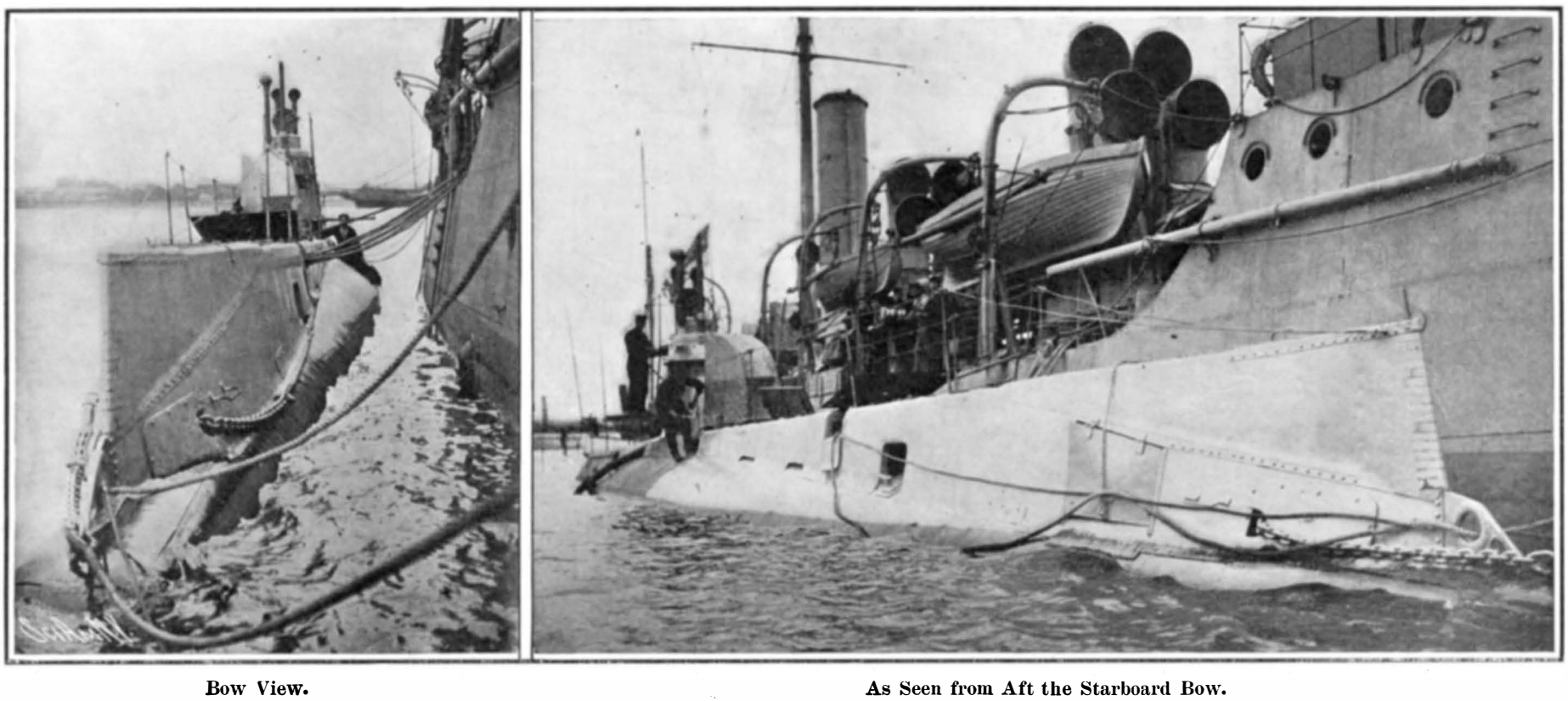
It is a well-known fact that any psychical process is attended by some alteration in the physical state of the body. The temperature of the blood is known to rise in the case of excitation, while chemical and physical actions of a nature yet insufficiently known will occur. There is on the other hand a mental state called *depression,* when the blood temperature falls and behavior of the body is in every respect the opposite of what is observed in the above case.

The physical changes just referred to form a criterion of the actual state of the mind, but it has not so far been possible to use them for an accurate determination of the psychical process going on. The much-discussed discovery of N-rays seemed to afford another outward sign of mental activity, Prof. Charpentier having shown that the amount of these rays given off by each nervous center is proportional to its activity. This outside manifestation of psychic activity would be of the highest interest, allowing as it would of explaining many phenomena hitherto enigmatic. Until, however, the existence and properties of these mysterious N-rays have become universally recognized, it would seem preferable to leave them out of account.

Now another physical criterion for the state of the human mind has just been found out by a Swiss engineer, Mr. E. K. Müller, of Zürich, Switzerland, and as this criterion is susceptible of accurate determination by the ordinary physical methods, we do not hesitate in describing the interesting results thus found.

Mr. Müller noted an interesting connection between the conductivity of the human body and its psychical and physiological condition. This conductivity, in the first place, undergoes great variation, according to the hour of the day at which the experiment is made and according to the meals taken by the person experimented on. Accurately identical figures will occur very frequently in series of experiments lasting from 10 to 15 minutes, with the same minutes and the same person, even in the case of experiments separated by an interval of some days.

The magnitude of the conductivity, as well as the regularity in the behavior of the different series, are highly influenced by the presence of a third person; whenever anybody enters the room or a noise is produced, the resistance of the person experimented on is found to undergo a spontaneous variation of extraordinary magnitude. Outside of objective



Bow View. **As Seen from Aft the Starboard Bow.**

Displacement, 300 tons. **Horse-power,** 850. **Speed:** Submerged, 9 to 10 knots; surface, 15 to 16 knots. **Radius of action,** 500 knots.

TWO VIEWS OF THE LATEST B TYPE BRITISH SUBMARINE. THE VESSEL LOST JUNE 8 WAS OF THE SMALLER A TYPE.

causes, any psychical influence, either internal or external, will result in an immediate oscillation of a sometimes enormous magnitude. Any sensation or psychical emotion of a certain intensity will reduce the resistance of the human body instantaneously to a value three to five times less.

Whenever the person experimented on is talked to or caused to concentrate his attention in some way or other, oscillations of the resistance will be produced. Any effort made for hearing a distant noise, any volition, any effect of self-suggestion, will exert a material influence, the same being true of any excitation of the senses, any light rays striking the closed eye, any body the smell of which is perceived (even where the smell or the body is fictitious). Any physiological action of some intensity such as breathing, stopping the breath, etc., is found to exert an analogous effect.

By making experiments both before and during the sleep, the author observed some characteristic variations according to the character of the latter and the vivacity of the dreams.

Any pain, either real or suggested, will modify the resistance, the feeling of pain being preceded and followed by an oscillation.

The individual resistance of the human body depends also on the nervous susceptibility and on the conditions the person is living in. Nervous persons, as well as strong smokers and drinkers, show an extremely low electrical resistance. The variability and temporary behavior of the resistance is also shown to depend on these factors.

Fig. 1 shows the measuring room which has been fitted out especially at the Salus Electromedical Institute, Zürich, for measuring the individual resistance of patients. The experimental outfit comprises a mirror galvanometer, having a strong damping coefficient susceptible of regulation, a scale for objective reading and electrical lighting, a standard resistance, an accumulator, commutator, and milliamperemeter, etc. This is put in connection by means of wires with "isolation rooms," where the persons to be experimented on put themselves in connection with the measuring outfit, by dipping their hands (during 10 to 15 minutes) into glass tanks containing a salt solution of low concentration or else by seizing cylindrical nickel electrodes.

The isolation room limits as far as possible any outside noise or processes liable to excite the attention of the person experimented on, thus altering the results of measurements. According to circumstances, the natural lighting of the insulation room is damped, softened by blue glass, or else replaced by glow lamps. The figures and curves thus obtained hardly ever show any alteration, so that they may be said to ascertain in a reliable manner the degree of nervous susceptibility (being inversely proportional to the individual resistance), the behavior of the person in question in regard to mental activity, and finally the frequency and intensity of painful feelings in the patient during measurements.

Fig. 2 represents the outfit for checking in an objective manner the action of an electromagnetical treatment, for instance in the case of a patient suffering from a headache. The head of the person is "radiated on" by an alternating magnetical field, thus becoming free from pain gradually, while at the same time the individual electrical conductivity of the body is found successively to decrease (the resistance increasing), and the oscillations in the measuring current, as observed before radiation, to disappear.

The behavior of the resistance curve corresponds to the state of pain and excitation of the patient, the purely subjective state thus being ascertained objectively by the measuring outfit.

Tube-shaped electrodes of zinc sheet, the bottom of which is perforated and coated with bladder, are filled with salt solution and tied to the palm of the person experimented on, thus insuring a perfectly uniform and safe contact, even in connection with prolonged experiments.

From the above the possibility is seen of ascertaining the nervous excitability of any given person and the alterations undergone by this factor under the most various conditions. It would seem possible also to find out from a number of investigations and measurements a given average resistance for what might be termed "standard" men. On the other hand, the action of electricity with therapeutical applications might be verified objectively.

Any experiments so far made bear out the hypothesis that in the case of the action of electromagnetic lines of force, an increase in the individual resistance occurs.

THE CREATION OF LIFE BY ARTIFICIAL MEANS.

(*Continued from page* 480.)

arouses the hope that it will soon be possible to undertake the solution of the various problems for which the raising of parthenogenetic larvæ in large numbers is a prerequisite.

Repeated experiments on the fertilization of the eggs of the sea-urchin with the sperm of starfish yielded the result that these eggs can be fertilized and caused to develop not only with the sperm of Asterias but also with the sperm of a brittle star and the sperm of the twenty-ray starfish. Furthermore, mollusks are added to the list of animals in which it is possible by physico-chemical means to cause the unfertilized eggs to develop into swimming larvæ. The hope of students of heredity, who have been looking for the means of raising animals in large numbers for experimentation, which should possess the hereditary traits of one parent only, has been at least attained.

The University of California has published from time to time the papers of Dr. Loeb in which is given at great length the progress of the experiments from which the results, often disappointing but at least convincing, have been finally attained. The immense labor involved can be understood only by advanced scientists, and do not appeal to popular interest. What the outcome may be, only the future, and not a very near future, can decide. The subjection of all Nature's forces has taken centuries to perfect, progressing little by little at a time. To create life may be one of the victories of science over nature for the future to achieve.

While occupying the chair of physiology in Chicago, Dr. Loeb had a laboratory at Holmes Holl, a site on the Massachusetts coast. In California, by the courtesy of the faculty of the Leland Stanford, Jr., University, the Johns Hopkins laboratory at Pacific Grove, located at the extreme southern point of the Bay of Monterey, has been placed at his disposal. At this point conditions the most ideal are at the command of the scientist. Probably no body of ocean water on the globe of similar extent is more prolific of marine life in all its forms. The buildings are close to the shore and equipped with every appliance for successful investigation.

Carded E. F.

MINES AND ENTANGLEMENTS IN THE RUSSO-JAPANESE WAR.

In the aftermath of correspondence that flows in from the seat of a great war subsequently to the occurrence of the leading battles and most decisive events of the struggle, there is nothing quite so interesting as the arrival of photographs taken on the spot by men who do not hesitate to risk life and limb in the pursuit of their profession. Sometimes with only a little pocket kodak, and at other times, as in the case of the veteran photographer whose pictures are shown on our front page, with a large 8 x 10 camera, the artist pushes his way up to the very front line of battle and snaps the shutter on the most critical scenes of the battlefield.

The Russo-Japanese war will always be noted by the historians as having seen the first practical test on a large scale of the many military and naval inventions which were produced in such prolific numbers in the closing years of the nineteenth century. But although many new weapons were put to the test, it was remarkable what an extended use was made by both belligerents of methods and implements of warfare that are as old as history itself. Port Arthur, which the Japanese expected to succumb to high-explosive shell, the hail of machine gun and rifle bullets, and the overwhelming sweep of charging battalions, proved to be absolutely impregnable against any such method of attack. It was only when Gen. Nogi resorted to the time-honored method of approach by digging parallels and approaches, and mining beneath the walls of the fortress that Port Arthur gave way; and it is a curious fact that in the assaults on the fortress, the soldiers on both sides when they got at close quarters made free use of that ancient missile, the hand grenade.

What could be more mediæval than our front-page picture showing the barriers thrown across the main road into Port Arthur from the north? Our minds are instantly carried to the curious old cuts in our school books showing the seemingly impassable barriers, by which in early times it was attempted to break up the charge of heavy cavalry or throw an assaulting body of men into confusion. In the immediate foreground of the picture is shown a series of "wolf-holes," concealed with diabolical skill among a forest of sharpened sticks. These holes are laid out on a diamond pattern and each is between three and four feet deep. In many cases a sharp stake is driven firmly in the ground at the bottom. Usually they have a wire entanglement running parallel with them. In some cases they were built without the usual forest of stakes being driven around them at the surface of the ground; in which case the openings were concealed by grass and brushwood, and the attacking force knew nothing of their existence until the men crashed through to be impaled on the stakes below.

Of the two extraordinary photographs, showing the explosion of mines, one was taken at the instant of setting off a Russian mine, containing 600 pounds of explosive in the siege line near the base of Nantezhan Fort. The other represents the explosion of a mine on one of the battlefields in Manchuria. The rocket-like threads of smoke and the black objects seen against the sky are flying pieces of burning powder and fragments of the boxes containing the powder. Although a considerable number of casualties of the war were due to the explosion of mines, the Japanese in several cases, when storming the fortified positions, succeeded in finding the wires leading to the mines, and by cutting them, rendered the ground perfectly safe for troops to pass over.

Correspondence.

Iron Used as a Money Medium.

To the Editor of the Scientific American:

I am a constant reader of the Scientific American, though not a regular subscriber, on account of the fact that I can get the paper at an earlier date from the news stand than if sent to me direct.

In your issue of April 22 I have read with interest an article by Prof. Alex. Del Mar, entitled, "Our Heritage of the Mechanical Arts." In giving the history of iron, its scarcity, usage, etc., the writer among other things says: "Both iron and steel were certainly very scarce in the West at the periods mentioned. Homer, tenth century, mentions poleaxes, shipwright's tools, plow shares, sheep hooks, and chariot wheels in the Troad; yet in Lacedæmonia, in the time of Lycurgus, ninth century, iron was still so valuable that he employed it as a material for money."

The writer seems to emphasize the point that Lycurgus used iron for money on account of its scarcity and value. It is true that Lycurgus did use iron for money, but not on account of its scarcity or value. On the contrary, he made use of iron for money to aid him in his new system, by which he wished to destroy the avarice of his people.

Plutarch says: "Not content with this [the equal division of the lands, etc., of the Lacedæmonians] he [Lycurgus] resolved to make a division of their movables too, that there might be no odious distinction or inequality left among them; but finding that it would be very dangerous to go about it openly, he took another course, and defeated their avarice by the following stratagem: he commanded that all gold and silver coin should be called in, and that only a certain kind of money made of iron should be current. A great weight and quantity was of very little worth; so that to lay up twenty or thirty pounds, there was required a pretty large closet, and to remove it, nothing less than a yoke of oxen. With the diffusion of this money, at once a number of vices were banished from Lacedæmonia; for who would rob another of such a coin? Who would unjustly detain or take by force, or accept as a bribe, a thing which was not easy to hide nor a credit to have, nor indeed of any use to cut in pieces? For when it was just red hot, they quenched it in vinegar, by that means spoiling it, and made it almost incapable of being worked."

Clare in his "Universal History of the World," vol. ii., page 585, says: "To render the state dependent only on its own territorial products, and to prevent any individual from accumulating an undue amount of wealth, he [Lycurgus] prohibited the use of any money except an iron coin, with so small a value in comparison with its bulk and weight, that the necessity of using it as a medium of exchange would make it difficult to carry on trade, especially foreign commerce. By subjecting this iron coin to a process rendering it brittle and unfit for a [an] other use, Lycurgus endeavored to destroy every desire to hoard it as a treasure."

Rollin, in his "Ancient History," vol. i., page 687, says: "First he [Lycurgus] cried down all gold and silver money, and ordained that no other should be current than that of iron, which he made so very heavy, and fixed at so low a rate, that a cart and two oxen were necessary to carry home a sum of ten minæ [five hundred French livres, about $88.80] and a whole chamber to keep it in."

This was done for the purpose of sapping the foundation of avarice.

From the above quotations, it would seem that while iron was much more valuable than it is now, still it was not so valuable as to justify its being coined into money. It seems that a team of oxen could haul about $88 worth of iron. I presume the same sort of team might haul one-fifth of that value of iron at the present date.

As stated, the idea conveyed by Prof. Del Mar in his article seems to be that iron was so scarce as to justify its coinage into money. I do not think that history will bear out this statement.

I do not know whether you care to have letters of criticism of this sort or not, but at any rate, venture to give you the facts as stated by ancient historians.

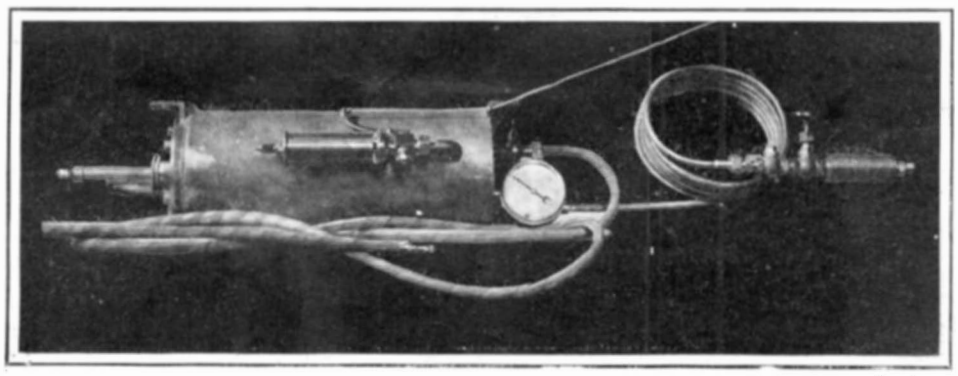
L. M. Neblett.

Fort Worth, Texas, May 25, 1905.

News comes to us from the Harvard Observatory at Arequipa, Peru, that Eros has been photographed there with the Bruce telescope. Eros, be it remembered, is the nearest of all the heavenly bodies, with the exception of the moon.

A POWER BRAKE AND WHISTLE FOR AUTOMOBILES.

A novel brake and whistle equipment for automobiles, the invention of Mr. Lewis S. Watres, has recently been placed on the market. The manufacturers have had considerable experience in this line. This company has manufactured for some time a whistle for launches operated by the explosive pressure obtained in the cylinder of the gasoline engine used to propel the boat, and the present device is an extension of this system to the operation of a brake piston arranged to travel in a cylinder placed within and at one end of a cylindrical reservoir. This tank, which is shown in our illustration, is formed of an aluminium casting 15 inches long by 6 inches in diameter and weighing complete 25 pounds. Within it, at the left-hand end, is the 3½-inch bore by 3-inch stroke brake cylinder, the piston of which carries a hollow rod forming its axis and extending beyond the piston a certain distance on either side. The left-hand end of this piston rod extends through the cylinder wall, and is provided with an eye for the attachment of the brake cable, besides having a hole through its wall for connecting its bore with the outer air. The right-hand end of the rod slides in a tube in that end of the brake cylinder, and said tube contains a spring, which returns the piston to the left-hand end of the cylinder as soon as the pressure, which, when let in behind it at that end, causes it to move to the right, is released. A small hole in the hollow piston rod on the right-hand side of the piston allows of the escape into the atmosphere through the rod of the air, which would otherwise be compressed when the piston moved to the right. The tank is connected to the engine cylinder by a copper pipe having a brass flanged radiating section, containing several layers of wire gauze, placed next to and connected to the copper pipe through a special steel check valve. The wire gauze keeps the flame from passing through the check valve and igniting any explosive gas mixture that might reach the tank if the engine is a multi-cylinder one, and the cylinder from which the pressure is taken should not be firing for a time. The connection to the engine cylinder is made through the compression relief cock, or by drilling a small hole in the cap above the inlet valve. The pressure in the reservoir will reach 80 or 90 pounds per square inch with a four-cycle engine, and about 125 with a two-cycle when running under a light load. If the load on the engine is a heavy one, the pressure may run up to 200 or 300 pounds. It is obtained in a couple of minutes after the engine is set going. The pull obtained on the brake rod is about 800 pounds with a pressure of 100 pounds per square inch in the cylinder. With the pressure as low as 40 pounds per square inch, the brake will operate successfully a number of times. The valve through which the compressed gas is let into the brake cylinder is a type of three-way valve, consisting of an ordinary poppet valve having a hollow stem into the top of which fits a small plunger carrying a ball that seats in a socket formed on the top of the valve-stem. The ball valve thus formed is normally open for the purpose of allowing the compressed gas to escape from behind the piston. When the end of the valve-opening lever moves downward, it first depresses the plunger until the ball on the latter becomes seated and prevents the escape of the compressed gas through the hollow stem. A further movement of the lever opens the poppet valve, and the compressed gas enters the brake cylinder. As soon as this valve closes, the pressure is allowed to escape from the brake cylinder through the hollow stem. Thus the brake is sure to be released the moment the poppet valve is closed. Both the valve and whistle are operated by cords running to the steering column. If it is desired to inflate the tires, a connection can be made to a cock on the right-hand end of the reservoir. The tire-inflating pipe is shown attached to this cock in the illustration. The outfit makes it possible to use the pressure obtained in the engine cylinder for three different purposes besides the propulsion of the car.



COMPRESSED GAS RESERVOIR CONTAINING BRAKE CYLINDER FOR AUTOMOBILE POWER BRAKE AND WHISTLE.

A novel device, the object of which is to remove the discomfort of steering an automobile in cold weather, owing to the hands becoming numbed by contact with the metal of the wheel, has been patented by an English inventor. The steering wheel is warmed by the water after its passage through the water jackets of the engine. This is done by means of a flexible tube connected to a hollow spoke, from which the water flows round the wheel, thence returning to the water tank. It is claimed that in half a minute the wheel is rendered thoroughly warm. This invention promises to be largely adopted in public service automobiles, where great inconvenience arises in wintry weather from this cause.

A Plate-Glass Machine.

An invention which will prove of great interest to the glass-making industry has been devised by M. Emile Fourcault, honorary engineer of the mines at Lodelinsart, near Charleroi. By means of this device the manufacture of sheets of glass by machinery, ready for use within half an hour of the incandescent state of the material, is rendered possible. The Fourcault machine can turn out continuously sheets of glass 39½ inches wide, of any desired length, and of a uniform thickness, varying from 1-16 to 5-16 of an inch. This glass can be obtained as rough glass for making extra thin glass, as horticultural glass, and window glass for certain export markets.

The Fourcault machine is essentially simple in design. There is a box of firebrick material which floats on a "springing fountain" of glass. In the bottom of this box is an orifice called the stretcher, and through this a sheet of plate-glass is introduced into the molten mass. The immersion of this sheet of glass causes the plastic molten fabric to adhere to it. When, therefore, the glass sheet is withdrawn in a vertical direction, it causes a nap of melted material to well up through the orifice without any effort, and this operation will continue as long as there is any molten glass in the well beneath, without any further dipping of the glass sheet in the stretcher. The "springing fountain," as it is called, comprises a well or pit. The molten material serves to heat the walls thereof so that the whole mass is in a heated condition. On the top of this pit is the apparatus which serves the dual purposes of dragging the glass up and annealing it.

This portion of the invention consists of a chimney to draw off the heat. In this chimney is placed a series of seventeen pairs of rollers. The plastic material in rising passes between these rollers, gradually cooling meanwhile, and by the time the mouth of the chimney is reached the glass is sufficiently cool to enable it to be cut off with a diamond into any required sizes. The annealing process is carried out simultaneously in the machine. As the molten glass issues from the pit it congeals and slowly cools, and soon loses its heat and the first pair of rollers through which it passes are of the same temperature as the glass itself. This arrangement overcomes the great difficulty in the present system of annealing in which the glass is brought into contact with tools and handled in a temperature considerably lower than its own. By the Fourcault method the glass when it reaches the top of the chimney is perfectly flat, and is equally bright on either side.

Utilizing Nitrogen from the Air.

In a recent article by Dr. K. Arndt in Dingler's Polytechnisches Journal, the process designed by Prof. Frank is discussed, according to which nitrogen is led over heated calcium carbide, thus obtaining a compound of calcium carbon and nitrogen (calcium cyanamide) called "lime nitrogen" by the inventor. The raw product, which contains from 20 to 21 per cent of nitrogen, can be used immediately as manure, when the following instructions should be attended to: On one hectare there is spread out 8 to 14 days before the sowing 150 to 300 kilogrammes of lime nitrogen (according to the condition of the ground) being mixed with about a double quantity of dry soil, and plowed immediately into the ground to 3 to 5 inches depth. A large factory is to be taken into operation in Italy in the course of this year, where 3,000 horse-power is to be used for the production of lime nitrogen. According to Frank's data, one electrical horse-power per hour will give during a year 1,250 kilogrammes of lime nitrogen. The product should be protected against moisture, lest some nitrogen be lost in the form of ammonia.

Whereas this process requires enormous amounts of electricity, Nature herself dispenses with such a large apparatus. In fact, the bacteria dwelling in the root nodules of leguminosa work the nitrogen of air, preparing from it food for their hosts. Hiltner of Munich succeeded in obtaining from these nodules considerable amounts of a substance by means of which he expects to find a biological process liable to compete with the above chemical method for the utilization of atmospheric nitrogen.

A MODEL PHOTOGRAPHIC LABORATORY.

BY C. H. CLAUDY.

The recently completed photographic department of the Geological Survey at Washington is a model plant in every respect. It represents the height of convenience, the greatest availability of apparatus for the greatest possible amount of use, and the largest possible economy of effort for the required output. This state of affairs exists as the result of most careful planning by the chief of the division, Mr. Norman W. Carkhuff, who has spent the five years during which he has been in charge of the work in tireless endeavor to save time and expense, and increase output.

Everything in this establishment is calculated to increase the efficiency of the individual workman. The apparatus is so arranged that the minimum of time is required for its correct adjustment, and the worker is made comfortable in every way possible, it being the theory that good air, plenty of it, and a cool temperature make for better work than hot, stuffy, and uncomfortable quarters; a fact which every one who has ever worked in an improperly constructed dark-room will at once appreciate. Nothing has been of too small a nature to receive attention, the littlest details, such as the size of the lens boards, the height of the cameras, etc., having been most carefully thought out. The entire result is a laboratory and photographic gallery which is unique in every way.

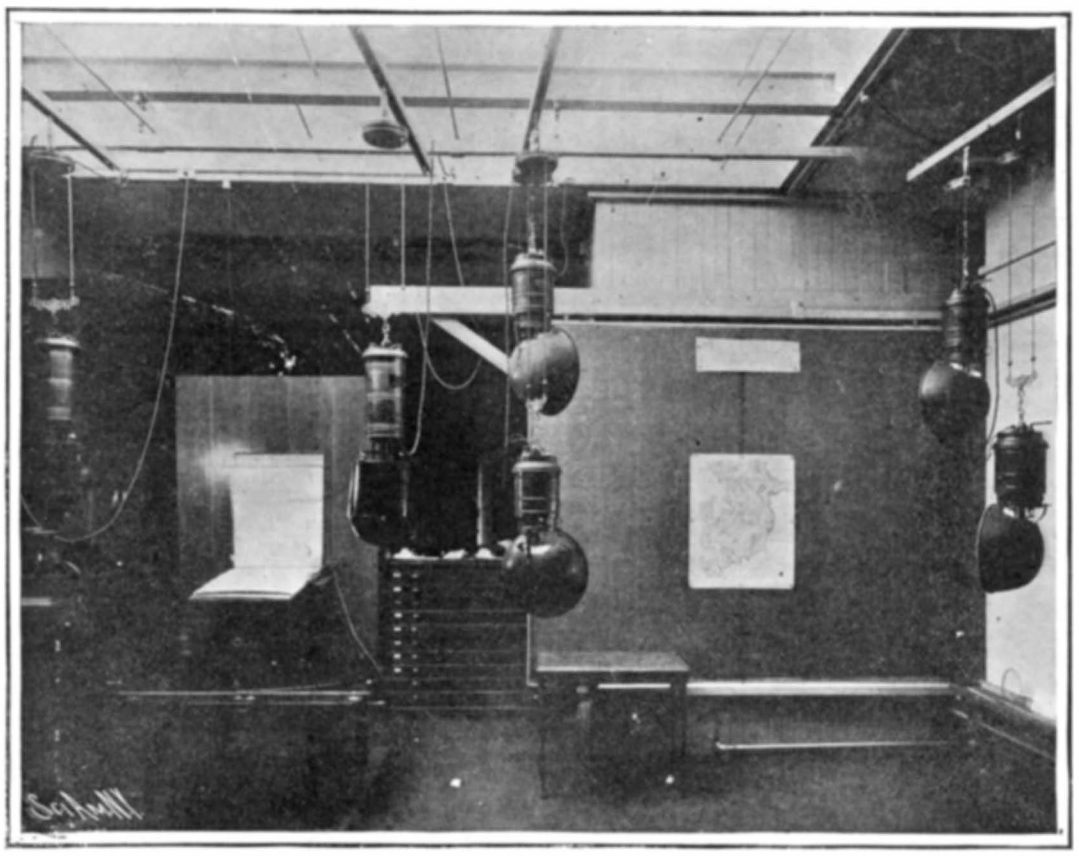
A more particular and detailed description follows, which should bring out these points. It must be mentioned, however, that in one respect this workshop, or series of workshops, is not as good as might be desired, and that is in the question of available floor space. The Geological Survey occupies the greater part of a privately-owned business building in Washington, which is too small for the immense interests it contains. Consequently, the photographic department is crowded into smaller space than it should be.

Entering the department, the visitor passes through the office to a door which can only be opened from the inside, except by those who know how. Passing through this portal, the visitor will find himself in a long and narrow passage, from which open doors, leading to the various rooms. Proceeding along this passage to the left, you enter the gallery, where the first work is done. Here are two large cameras, each taking a plate 28 x 34 inches in size. These cameras slide back and forth on tracks, where they can be instantly locked in position at any point. The fronts of both these cameras are movable up and down, and back and forth, which movements are controlled from the rear by means of revolving rods connected to gearing. This simple idea took considerable working out, but the mechanism was finally simplified to a practical working basis. The result is a saving of several hours a week, otherwise spent by the workmen running around the camera from under the focusing cloth, to adjust the position of the lens. There are twelve lenses in this department, ranging from 20 millimeters to 31 inches in focal length. Except those used only in microscopical photography, every lens in the place is on its own front board, and every lens will fit every camera, without any adjusting, another simple feature which saves much time. The plate holders for these cameras are heavy affairs, naturally, and usually take two men to carry them. Here, however, they are suspended from an overhead trolley line, which runs both lengthwise and transversely, so that they may be carried from dark-room to camera and back again by one man with the greatest ease. The plate holder remains hooked to this trolley all the time. Instead of being carried around the passage and into the wet-plate dark-room, that room has an opening in its wall, leading into the gallery, into which the plate holder just fits, and where it can be instantly locked to make a light-tight joint. The plate is prepared in the dark-room, slipped into the plate holder, which is then closed, and, if desired, the opening can then be closed also, with a shutter, keeping the dark-room light-tight when the holder is removed. Stepping into the gallery, the workman unlocks the holder, and simply pushing it on its trolley guides it to the camera he wishes to use. A slight pull on a handle raises it the inch necessary to fit it over the dowel pins, and the work is done. The opening in the dark-room is at the exact height that the plate holder is, when suspended from the trolley. The amount of work saved by this system is incalculable, but it amounts to a very large percentage. Besides requiring the services of only one man, it enables him to work with the utmost dispatch.

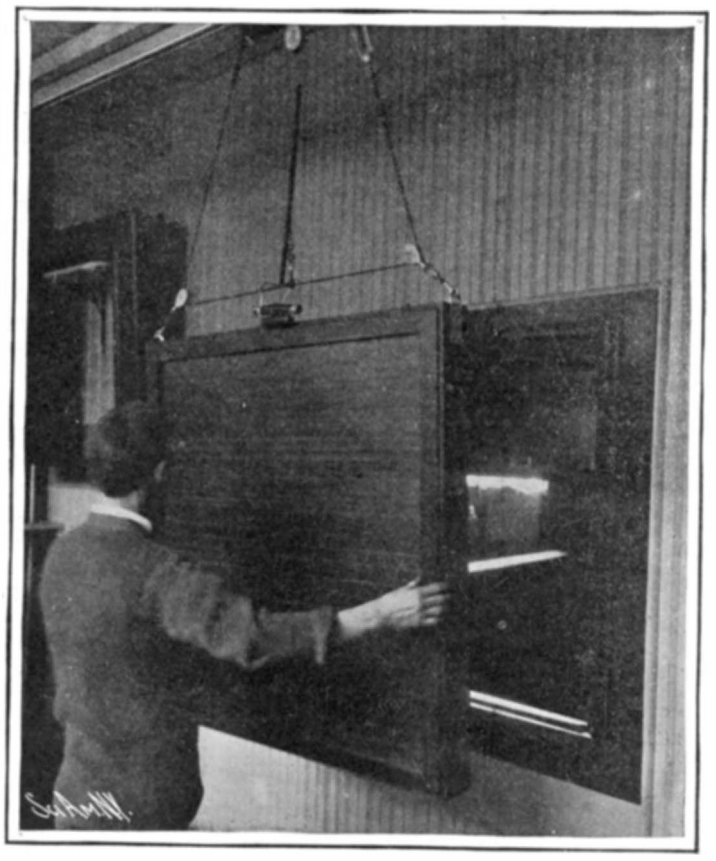
The trolley system is also applied to the electric lights used to illuminate the copying boards. These lamps can be placed in any position anywhere about

the copying boards, and at any height, and all by simply pulling or pushing them into position, where they stay where they are wanted. This arrangement shows the most critical lighting to be made in the minimum of time, a very important consideration, as orders for copies of maps are often sent for immediate filling. The copying boards are square to the beds of the tracks of the cameras, which beds are cement, laid on the iron structure of the building, so that no vibration caused by walking around or other movement can affect the exposure.

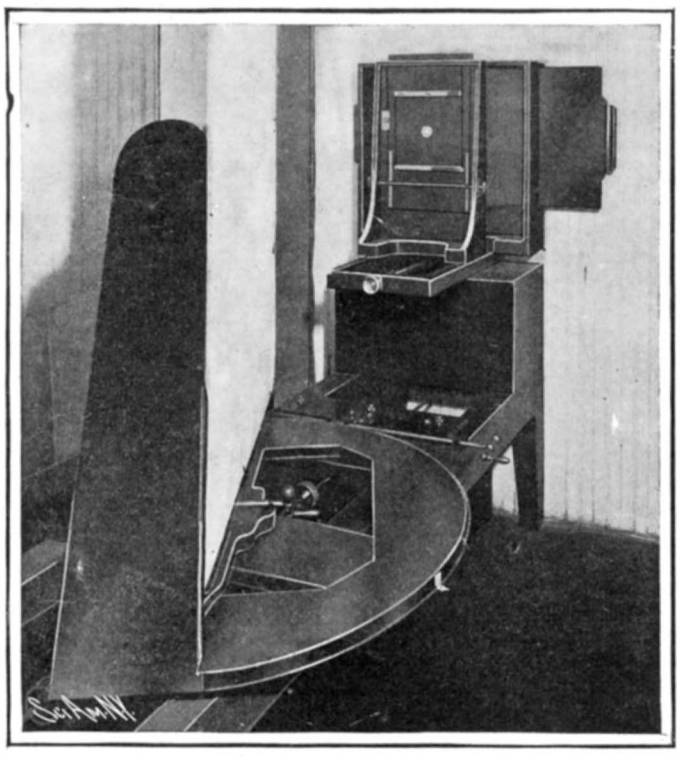
Next to the dark-room, where the wet plates are prepared and developed, comes the intensifying room, then a washing room, then a drying room, and lastly a glass cleaning room, all in a line, so that the plate has never to be moved backward, but always progresses forward. Further down the passageway is the printing room, of which there are here presented



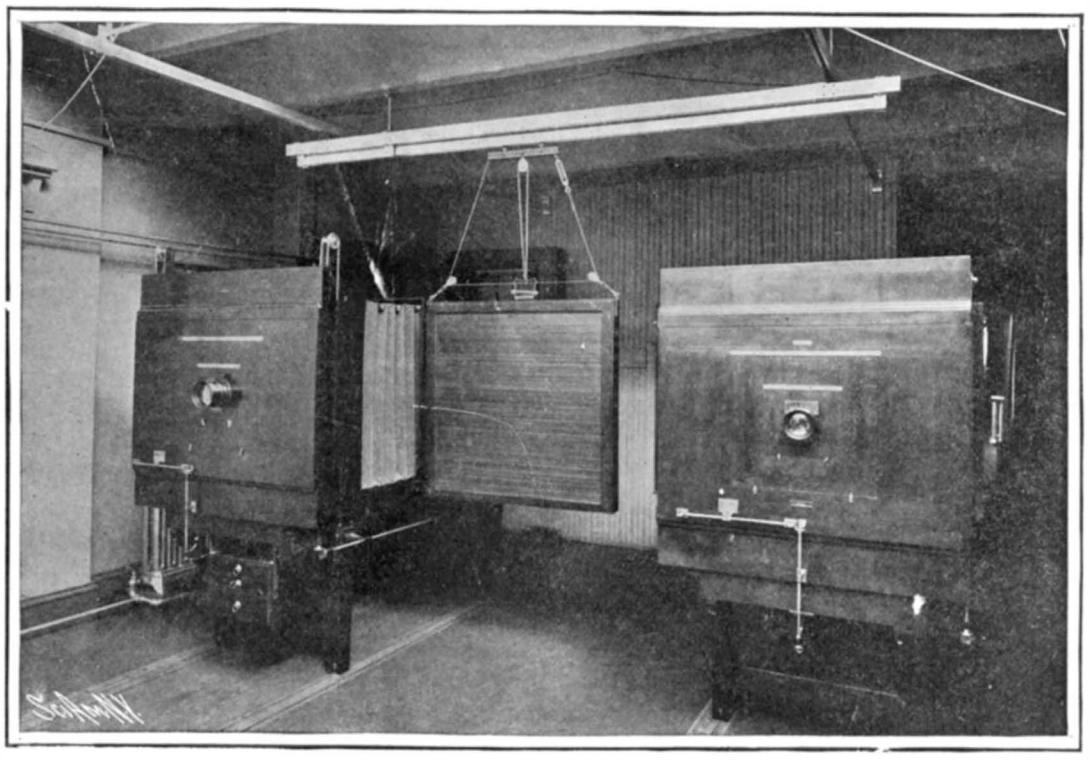
The Gallery with Boards and Electric Lights on Trolleys.



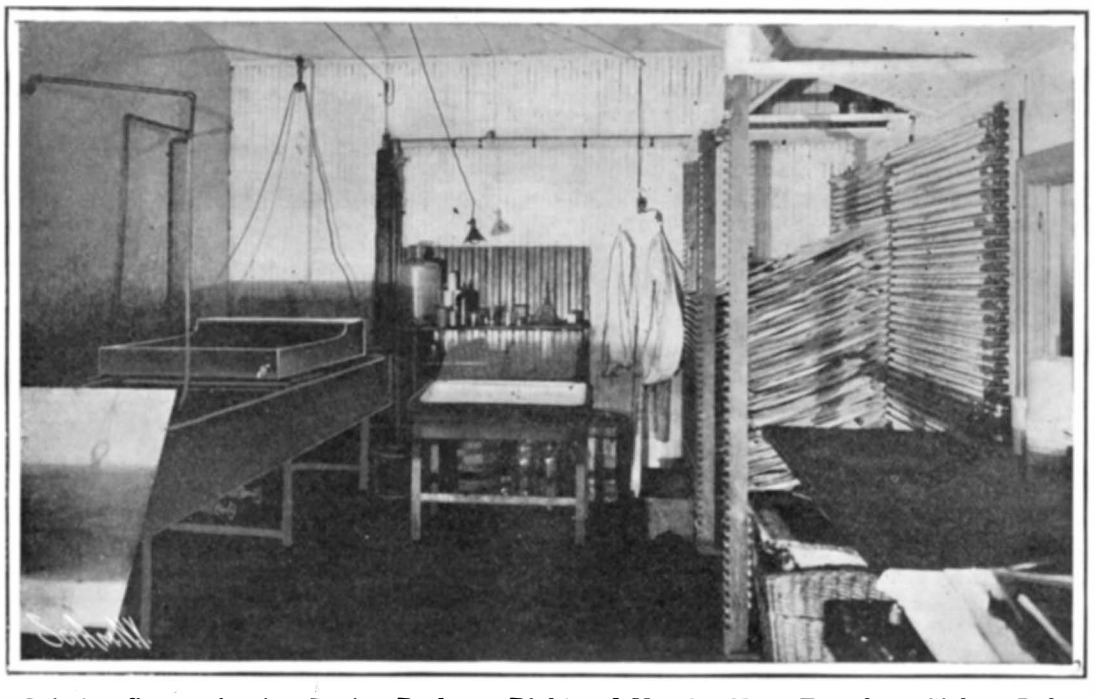
Taking the Plate-Holder from the Dark-Room by Trolleys.



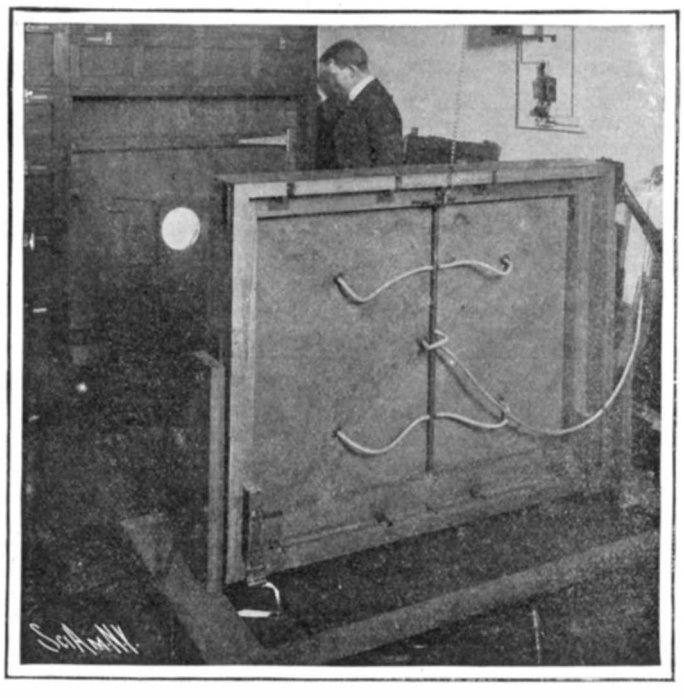
Enlarging Apparatus; 11-Foot Bed. Easel is Turned About to Show Its Face. Lens Can be Moved by Means of Guide Rod from Any Position Along the Bed.



The 28-inch by 34-inch Camera with Plate-Holder on Trolley. On the Front Board of Each Camera the Gearing May be Seen by Which the Lens is Raised, Lowered, or Shifted Back and Forth in Focusing.



Printing Room, Showing Drying Racks on Right and Movable Hypo Trough on Sink at Left.



The Printing Room and the Pneumatic Printing Frame.

A MODEL PHOTOGRAPHIC LABORATORY.

two illustrations. The printing, both from wet-plate negatives and from paper negatives, is done in a large pneumatic printing frame. This is designed expressly for the work, and so far as the locking and attaching of the rubber cloth is concerned, is the only one of its kind extant. Although it requires most careful locking to be effective, Mr. Carkhuff devised a means whereby the locking and unlocking of the back of the frame could be accomplished in one movement of a hand lever, instead of the eight separate movements formerly required. An air-pump exhausts the air from this frame, applying thousands of pounds of atmospheric pressure to the negative and paper, and thus insuring an absolutely even contact between them. The back of the frame is counter-balanced, to avoid the needless exertion of strength in raising and lowering it. The frame stands in front of a shutter, behind which is a powerful electric light. This shutter is operated by a foot-lever, and for the average exposure is made to wink in about a half second. A specially-prepared developing paper is used, particularly adapted to printing in line, which is the bulk of the work done here.

The print is developed by hand and fixed in a large bath, which can be seen on the end of a big washing sink; this can be swung up out of the way when the latter is wanted for washing the print. The fixing solution collects in a partition at one end of the big tray, and remains there until the tray is lowered, when the solution resumes its former position. When the prints have been washed, they are dried in racks, consisting of spring rollers on which is wound cloth. Through the free end of this cloth, which ends in a turn-over, is thrust a stick. Uprights with serrated edges stand the proper distance from these rollers, and the stick is so fitted as to slip into these serrations. By this device an immense number of prints can be dried at once, and in a very small space, and when no prints are being dried, the cloth stretchers are out of the way. The uprights are movable, also, so that this entire space is available for other things when wanted. In the photograph showing the printing frame and its light, will be seen a large oak case. This case holds the various sizes and varieties of paper used. Each separate flat cupboard has a false bottom, which can be readily removed. When a fresh consignment of paper is received, this false bottom is taken out, loaded with the paper, and slid back into place. Any one compartment can be opened without exposing the others, and the paper is absolutely safe in them. By using a scheme of this kind, not only is a great saving effected in paper, but in the time required to handle it, and in space formerly occupied by the boxes in which the paper is packed. The ventilation scheme comprises electric fans so placed that they do not merely agitate the air, but actually carry it out at the top and draw fresh air in from out-of-doors.

In the smaller dark-rooms and velox printing rooms, the small work is done. The Geological Survey takes thousands of pictures in the field every year, and these are all developed and printed here. There are a number of small dark-rooms, each a model in its way, and all absolutely clean. The keynote of the whole establishment is absolute cleanliness, and the photographic visitor at once remarks the absence of paper on the floor, junk in the corners, and useless bottles and chemicals on the shelves.

Eleven men are regularly employed in this establishment, and with the great number of labor-saving devices, they easily do the work of triple their number under ordinary circumstances. It is necessary that they should, for the twenty rooms of the laboratory will not stretch, and the work must be done by the force which can be comfortably put in them. Hence every improvement which is made must be either to save space, time, or money.

It is by no means possible to cover such an establishment fully in a short article. There is, for instance, the microscopy room, where the rock section photomicrographs are made and nothing else. Then there is the fossil laboratory, where these interesting objects are photographed with special apparatus designed for that work.

The Pleiades Showing Nebulosity.

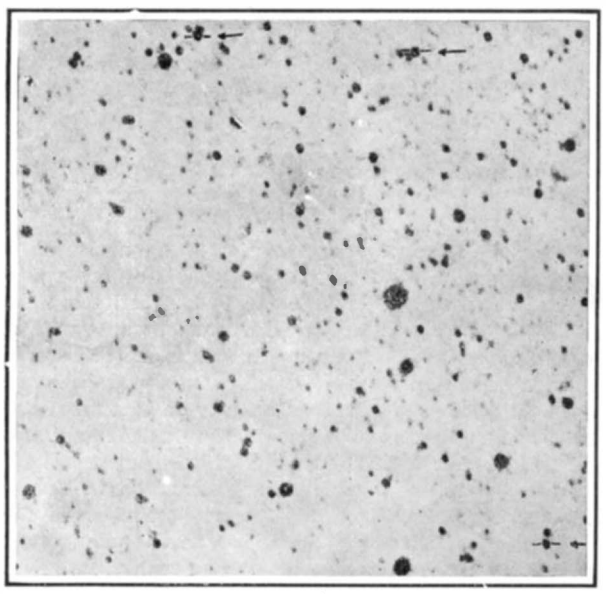


Fig. 1.—Showing About 0.001 of a Region Near the Center of Small Magellanic Cloud.

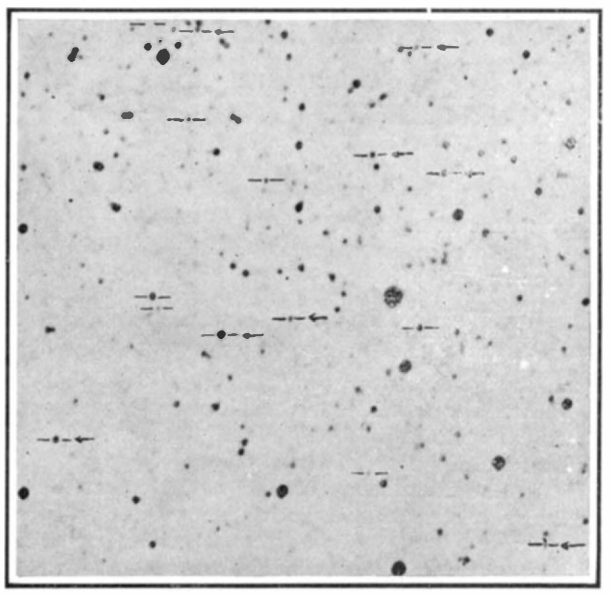


Fig. 2.—Same Region as Fig. 1, Showing Changes in the Stars.

SOME UNUSUAL DISCOVERIES OF VARIABLE STARS AT HARVARD OBSERVATORY.

BY G. A. THOMPSON.

Although it has long been recognized by astronomers that an investigation of the nebulous regions of the sky would yield much useful information, owing to the great amount of work already in progress at Harvard Observatory, a special detailed study of such regions for the detection of variable stars was begun there only during the past year. Except the great nebula of Orion, which has been the subject of careful study with observers for years, and the large and small Magellanic clouds, almost nothing was known of existing conditions in such regions prior to this beginning. The number of known variables eighteen months ago was about 1,500, of which about 970 were found at Harvard after 1890. About 200 of these were discovered by Mrs. W. P. Fleming, curator of astronomical photographs, from photographs of their spectra; about 500 others by Prof. Solon I. Bailey of the Arequipa station of Harvard Observatory, through examinations of star clusters.

Prof. Edward C. Pickering, director of Harvard Observatory, already and for a long time deeply interested in this subject and aware that an unusual harvest of scientific fact might be gathered from a thorough and detailed study of variable stars, which he believed would be found in large numbers in the nebulous regions of the sky, was most anxious to begin such an investigation at Harvard without delay. A grant made by the Carnegie Institution for 1903 permitted a large amount of work of this kind to be undertaken at Cambridge, and furnished a corps of eight observers for the study of the Harvard photographs. But the failure to continue this grant for 1904 rendered it necessary to disband this corps, and since December, 1903, similar work has been carried on at the expense of the observatory by one observer only—Miss Henrietta S. Leavitt, who began her present investigations during the latter part of February, 1904.

In 1901 and again in 1903, Prof. Max Wolf, of Heidelberg, compared several of his photographs by means of stereo-comparators, the small stereoscopic instruments which have proved so important a factor in astronomical work, and of which we are likely to hear more and more in future astronomical investigations. Prof. Wolf thus found and announced 33 variables in the neighborhood of Orion. But until the present investigation at Harvard, they do not appear to have been confirmed by other observers. Some photographs of the nebula of Orion are contained in the Harvard collection, and a careful examination of them was made by Miss Leavitt early last year. Besides confirming 18 of Wolf's variables, she thus found 72 new ones. It is possible that many others will also be discovered in this region, when more photographs become available for comparison, as many of those found appear to remain at their minimum magnitude during a large part of the time. The plates for the examination were superposed successively upon a glass positive made from one of them, after the method

Orion, Showing the Great Nebula.

The Nebula in Carina.

followed in such investigations at Harvard. A curious fact regarding the variable stars in this region is that they are found within and following the denser distribution of the nebula.

In no respect have the results of photography been more striking than in the revelation of diffused nebulæ of vast extent, whose faintness renders them almost beyond the reach of visual observation. One of the most remarkable of these extends over many square degrees in the constellations of Scorpius and Ophiuchus. Like the nebula of Orion, it attaches itself to individual stars, the principal condensation being about the quadruple star η Ophiuchi. The region is marked by a noticeable absence of stars of the fainter magnitudes, and dark lanes can be traced in different directions for a considerable distance beyond the visible nebulosity. An examination of a part of this region has led to the discovery of seventy-two variable stars, besides the eight already known.

In the trifid nebula in Sagittarius, which is near the center of a large number of the photographs taken for the study of Phœbe, the ninth satellite of Saturn, discovered by Prof. William H. Pickering in 1899, a careful search for variables was made by Miss Leavitt during the latter part of 1904. Yet only sixteen were found. A little earlier in the year, however, in the course of an examination of this region, a very interesting variable of the Algol type was discovered. Over 300 plates were available for the study of the new object, on twenty-eight of which it is fainter than the normal brightness, magnitude 9.55. In three cases it appears faint on two plates taken during the same night, so that twenty-five different minima have been observed. The observations indicate that the period is about 3.45 days, with a range of about one magnitude. An interesting and unusual feature in the variation is found in the fact that a secondary minimum occurs between the primary minima, and is about three-tenths of a magnitude fainter than the normal brightness.

The most fruitful field, however, that has been examined is the small Magellanic cloud, where up to the present time 900 variable stars have been discovered and sixty-four others suspected of variability. In a circular issued by Harvard Observatory May 26, 1904, announcement was made of the discovery of fifty-seven new variable stars in this region. In order to provide material for the study of the light curves of these stars, sixteen excellent photographs, having exposures of from two to four hours, were taken last autumn at Arequipa, with the 24-inch Bruce telescope. These plates reached Cambridge in January of the present year, and an examination of them by Miss Leavitt led to the surprising discovery that hundreds of variable stars were present in this region, the small number found in her earlier examination being due to the unsatisfactory quality of many of the plates.

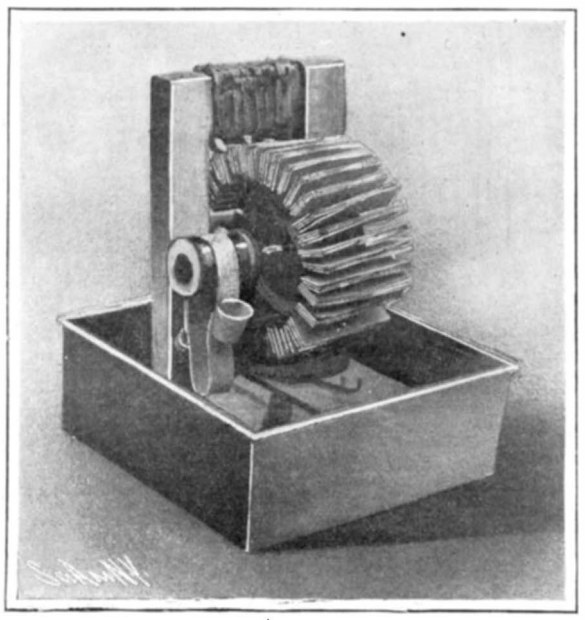
Nearly all the variables are found strictly within the limits of the cloud. Few have been found at a greater distance than a degree and a half from the center, excepting in the clusters 47 Tucanæ and N. G. C. 362. To study their distribution, the region of about six by seven degrees, covered by the plates, has been divided into squares which measure approximately half a degree on a side. The center adopted is not far from the center of the cloud, which extends diagonally in a direction from northeast to southwest. The limits of the region containing the variables are more sharply defined, and are closer to the central line of the most densely crowded portion on the preceding than on the following side.

Several examples of variability are shown in Figs. 1 and 2, which are enlarged six times from the original photographs, and cover about one-thousandth of the entire region. The area represented is 12 minutes square. Fig. 1 is an enlargement from Plate A3393, taken November 10, 1898, exposure 300 minutes, and Fig. 2 is from Plate A6981, taken September 30, 1904, exposure 240 minutes. All the variables in the region are marked on the latter, while on the former three stars are marked of which the changes are well seen on this pair of plates. There are many other regions of equal interest. No catalogue stars are contained in these regions, as even the brightest are too faint to appear in the Cape Photographic Durchmusterung. The number of stars shown in the photographs, in the central portion of the region, is about thirteen to a square minute of arc, or 46,800 to a square degree. It is estimated that the number of stars photographed in the small Magellanic cloud and adjacent clusters is about 280,000, of which 910, or one in 308, is variable.

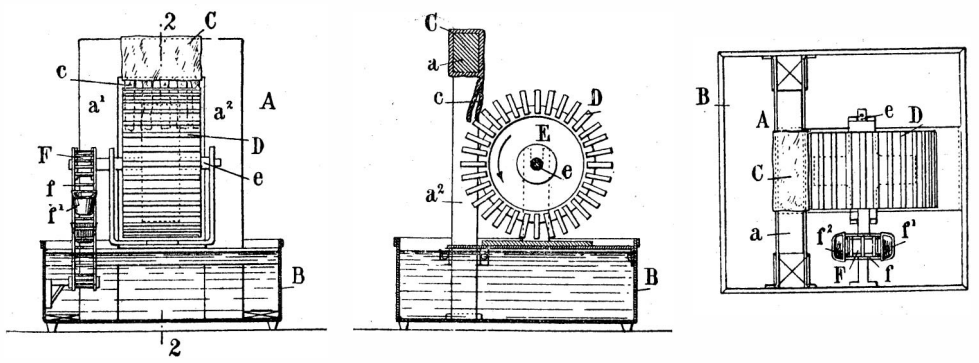
The results of this great scientific undertaking have been thus far very gratifying. In a little more than one year the number of known variables has been almost doubled, and a great deal of interesting and important information secured. One of the most interesting facts established is the great and often surprising dissimilarity of different nebulæ. In the beautiful cluster of the Pleiades, for instance, which is nebulous, and where one might expect to find an especially large number of such stars, no cases of variation have yet been found. In the nebula surrounding η Carinæ, considered by many the finest nebula in the sky after Orion, very few variable stars have been found. The large Magellanic cloud, also, similar in formation though it is to the small Magellanic cloud, seems to contain but few, if any, variables; out of 867 star images examined last year in the looped nebula, two were suspected of slight variability. The facts as they exist at present render such regions doubly interesting, since they illustrate how impossible it is to deduce any rule that will govern all nebulous regions alike. Even with regard to the type of variation found in the various nebulæ there is little similarity. Each nebula is a law unto itself.

The total number of variable stars that have been discovered by Miss Leavitt since she began her investigations in February, 1904, to the date of writing this paper is approximately 1,300. Yet the work is hardly more than begun. For the collection of photographs at Harvard includes nearly 200,000 plates, giving an exhaustive history of the sky during the past sixteen years, and of the more interesting regions since 1883; not only must the majority of these be carefully examined, but as new plates are constantly being taken at the Cambridge and Arequipa stations, fresh work is constantly being added. Moreover, it is possible that the large reflectors, now being mounted at Harvard and elsewhere, will make apparent new nebulæ too faint to be detected on present photographs, and that among the stars of the very faint magnitudes that will appear on these future plates will be found many cases of variation.

A discussion of this examination and of the work entailed by it would not be complete without some mention also of its effect upon another department of the research at Harvard. A complete bibliography of all the variable stars then known was begun there some years ago by Prof. W. M. Reed, now of Princeton. This work was resumed in September, 1900, and has since been continued by Miss Annie J. Cannon, so that there are now more than 35,000 cards. A minute record of every observation of each star in the series is thus kept, with the name of the observer, the observatory and instrument, as well as the technical description of the star, its position, period of variability and dates of maximum and minimum. Not merely, therefore, is the present study of nebulous regions adding a long list of variables to those already known, which in itself would be simply an interesting event in the course of scientific progress, but it will furnish an amount of detailed information concerning them, which will prove of inestimable value to astronomers and to others who are interested in the science.



A MOTOR DRIVEN BY CAPILLARY ATTRACTION.



END, SIDE, AND PLAN VIEWS OF THE CAPILLARY MOTOR.

THE CAPILLARY MOTOR.

BY DR. ALFRED GRADENWITZ.

A highly interesting application of capillarity for motive purposes has recently been patented by a French engineer, Mr. G. Leboyer, of Riom, Puy de Dôme.

Certain rocks, and especially those met with in volcanic countries, possess an exceptional power of capillary attraction, rendering them well adapted for the generation of small powers. A rotary apparatus utilizing this property is represented in the accompanying photograph, and shown diagrammatically.

The apparatus consists mainly of a frame of domite, *A*, of inverted U shape, the uprights, a^1 a^2, dipping into the water of the reservoir, *B*, and serving to convey the latter by capillarity up to the top, *a*.

This top part of the domite frame is in intimate contact with a convenient spongy substance, *C*, amadou for instance, which absorbs the water as it is drawn up by the domite uprights, a^1 a^2. This water is led by amadou filaments, *c*, to the paddles, *D*, of a wheel, *E*, conveniently balanced and mounted in front of the frame, *A*, so that the lower paddles never dip into the water of the tank, *B*. These paddles, *D*, which are always in free contact with the amadou filaments, *c*, are made of a spongy substance, blotting paper, domite, or the like, and receive the water, as has been stated above.

The paddles, *D*, are mounted in proximity to the amadou filaments, *c*, will be charged with moisture so as to destroy the equilibrium of the wheel, *E*, and to impart to the latter a rotary movement until the equilibrium is re-established. As, however, the water-saturated paddles are removed from the amadou filaments, *c*, the moisture contained in them will be vaporized, so that the equilibrium is once more destroyed, the upper paddles continually absorbing water from the filaments. The paddlewheel thus receives an intermittent movement of rotation, which may be utilized (as shown in the accompanying diagram) for raising water from the tank, *B*. For this purpose the shaft, *e*, of the wheel is fitted with a drum, *F*, or any other convenient attachment in connection with a chain of buckets, *f*, f^1, f^2.

The above principle can obviously be modified in many ways, using for instance instead of the reservoir the bed of a river or of a canal, substituting for the wheel a cross beam weighted on one side with a counterpoise, and bearing on the other one or several masses of spongeous matter.

The apparatus is interesting chiefly on account of the novel principle it embodies. It should be highly instructive in connection with practical demonstration, to show the effects of capillary attraction in school laboratories. Here, moreover, it may prove useful for the production of small amounts of motive power, and so really serve as a practical motor.

New Use for Old Boiler Tubes.

When visiting coal and metal mines, the writer has seen many piles of discarded boiler tubes. This is the case more often, where bad water is used in the boilers, and where the boilers have not had proper care in the way of cleaning; resulting in heavy deposits of scale, corroded and leaky tubes, which have to be cut out and replaced by new ones.

These old tubes or flues, when sold as scrap, bring so little that it hardly pays the cost of moving them; yet, a few dollars spent in cleaning them and attaching flanges, will make of them excellent air or water pipe which can be used where the pressure carried does not exceed 75 or 100 pounds per square inch. Wherever compressed air is used or water is to be pumped, the outlay for pipe is one of the large items of expense, and when used underground, only a small percentage of this pipe is returned to the surface in a serviceable condition.

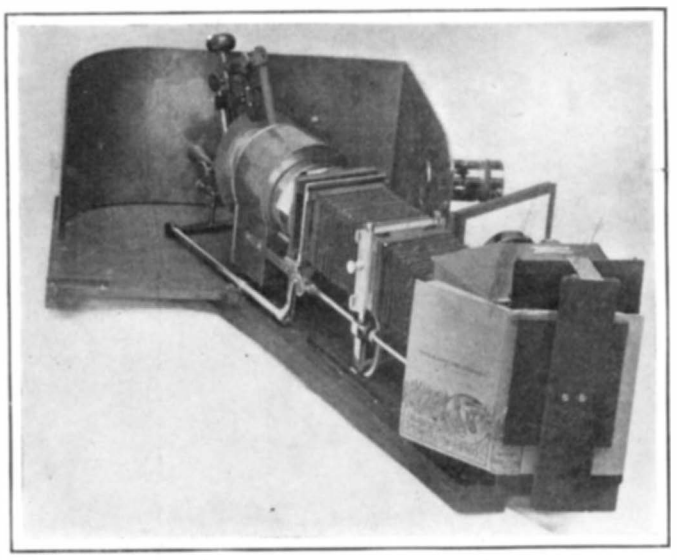
A year or more ago a company had several hundred old boiler tubes mostly 3 inches, 3½ inches, and 4 inches in size and 16 to 18 feet long which were considered practically useless until experiment proved their value for pipe.

Threads and couplings cannot be used with success for joining the various lengths, for two reasons. First, the old tubes are usually too thin to allow for the threads, and secondly, they are apt to be out of a true circle. Flanging is therefore the best method for this purpose.—From article by D. E. Rust, in Mines and Minerals.

Another single-phase electric railway has been put into service in the United States. The Bloomington, Pontiac, and Joliet Electric Railway, designed to run from Bloomington, Ill., to Joliet, Ill., through Pontiac and Dwight, Ill., has been put into operation on a length of about 10 miles from Pontiac. A trolley line voltage of 3,000 volts is used.

A NOVEL REFLECTING LANTERN.

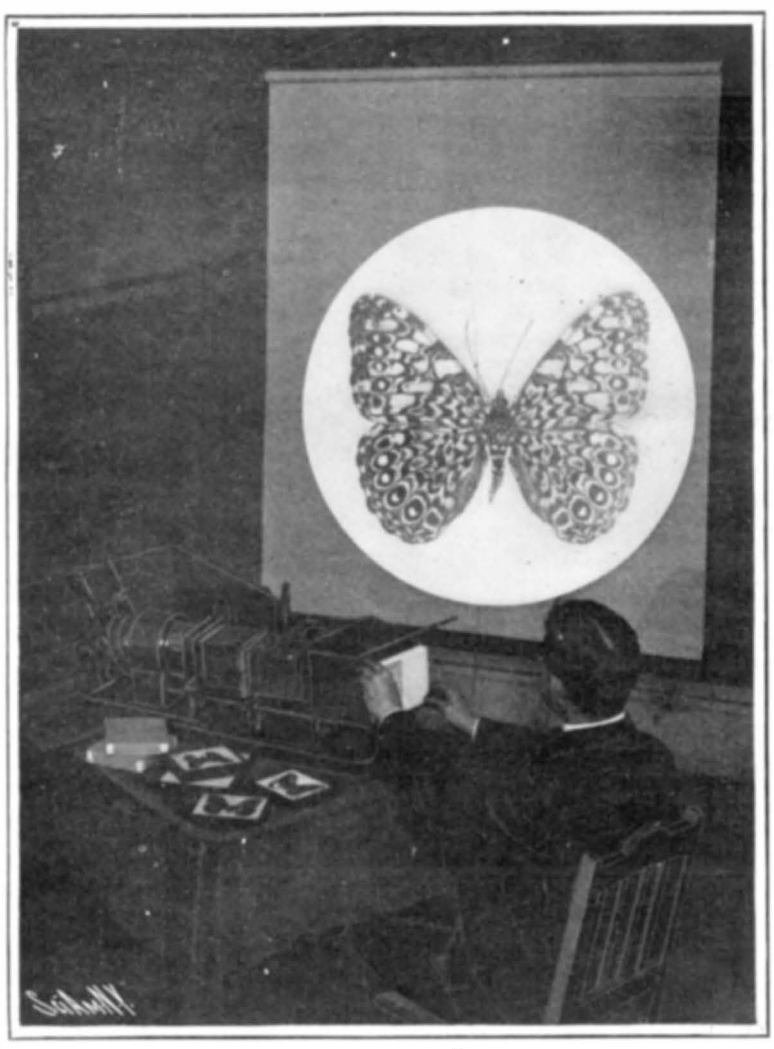
A new form of lantern has recently made its appearance, which differs markedly both in its optical principles and in the results attained from the ordinary projecting apparatus which the lecturer is accustomed to use. Limited as it is to the utilization of slides only, the ordinary lantern renders it impossible to use directly illustrations from books, sketches, specimens, and models. Photographs of these various objects must first be made, and from the negative a lantern slide prepared. Even though the resulting slide may be sharp and clear in every detail, it still presents the defect of presenting its subject in dead black and white tones. Attempts at coloring, although sometimes successful, are often the cause of many grievous errors on the part of the artist. The apparatus which we are about to describe, and which has been recently introduced by the Philadelphia instrument makers, Williams, Brown and Earle, projects on a screen not only the image of a lantern slide, but reflects as well pictures in books, specimens of insects, or other natural objects, mechanical models and the like, and this all in the natural colors of the objects. The lecturer is thus enabled to make use of the countless illustrations in magazines and books, of an innumerable series of color prints, sketches, photographs, and of working models that can be shown in motion on the screen, as well as apparatus for experimenting in chemistry and physics, specimens of plants, flowers, and moths, all in the delicate tints of the originals.



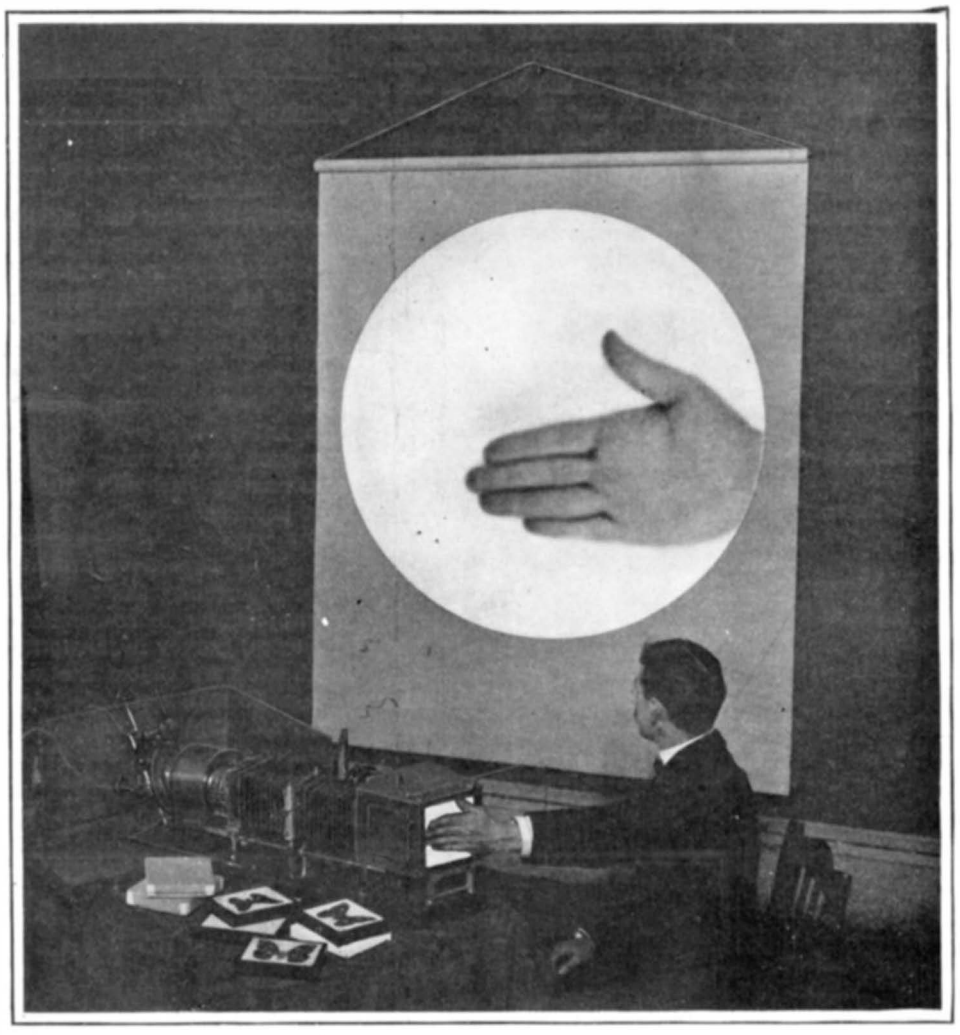
The New Lantern for Exhibiting Any Object in Its Natural Colors on the Screen.

The optical principle of this apparatus is well shown in the diagram. The source of light, *a*, sends forth its rays to the lenses, *b* and *b'*, which are condensers of the usual stereopticon type. The diaphragm, *gh*, is employed to give a sharp, clear outline to the beam of light, so that the picture when presented on the screen is clear. By means of an illuminating lens, *e*, a cone of light from the condenser is projected upon the object, *c*, every part being uniformly illuminated. The lens, *e*, is used either for spreading the light over the entire object, or condensing it upon a small portion when a very brilliant light and special details are desired. When the lens, *e*, is shifted toward the source of light, the rays are distributed over the entire object; when the lens is drawn toward the object, *c*, the beams condense and concentrate on the point desired. An image of the brilliantly illuminated object, *c*, is projected by the objective, *d*, upon the mirror, *f*. The image of the object, *c*, has been reversed by the objective, *d*, before the mirror restores it to normal position.

Particularly important factors in utilizing this apparatus are the diaphragms, which give a perfectly clear edge to the image on the screen, and the illuminating lens, *e*, which distributes the light evenly over the object at *c*, reducing or increasing the surface illuminated at the will of the operator, and producing a most intense illumination; and lastly, the reversing mirror, which projects the image upon the screen in its proper position, so that printed matter is read correctly.

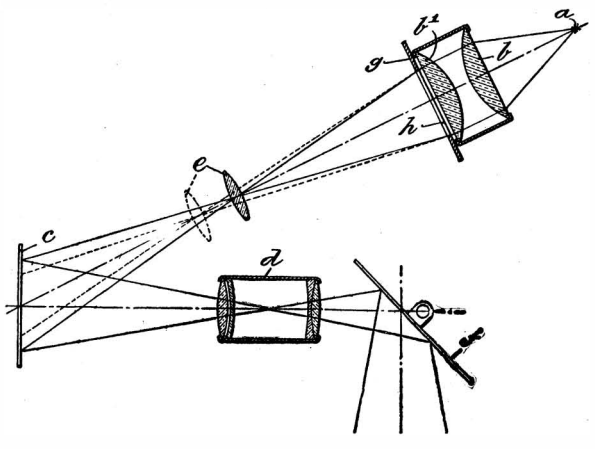


A Butterfly on the Screen.



How the Human Hand is Thrown on the Screen.

Exploration of a Deep Abyss.—The monthly review of the Italian Alpine Club announces the preparations for exploring the chasm in the calcareous plateau of Causiglio to the east of Belluno (Venetia) and attributes to it a depth of 460 meters. This measurement, if correct, would perhaps render it the deepest chasm known, but the soundings, so far, have only reached 259 meters, and the estimates beyond that are based on the time elapsing in the fall of stones. The expedition is regarded as perilous.



Optical Principle of the Reflecting Lantern.

Labor on the Isthmus of Panama.

No American white laborers should come to the Isthmus of Panama seeking employment unless previously engaged by the Commission. At first, before the organization here was fully completed and civil-service methods were applied, work could usually be found for able-bodied white laborers who might arrive here from the United States, or from any other part of the world. Now, however, the situation is changed. Whenever any department of the Commission on the Isthmus desires additional white or skilled labor it communicates with the central office in Washington, and the men are employed there and dispatched by the first steamer following; but even upon their arrival there is sometimes a delay in putting them to work, because the conditions may not be adjusted. When laborers come of their own accord the chances are against their employment.

The result is that a majority of such men find themselves, after a short stay on the Isthmus, without funds or work. If it were possible for them to do manual labor in the sun like the Jamaicans, at corresponding wages, there would be plenty for them to do, but they cannot stand that class of work. Finding themselves in these straits, they come to the legation and the consulates, and, not knowing that there are no funds provided by the United States for the care of indigent or stranded Americans, expect the minister and consuls here to provide them with food and lodging until they can get employment, or to give them passage back to the United States. It is often difficult to persuade them that the minister and consuls are not responsible for their condition. The minister has frequently assisted, and is now assisting, men in these straitened circumstances, but of course a limit must be placed on such charity.

When questioned, these laborers say they gained the impression from the papers that there was abundance of work at high wages here for everybody, and in most instances they gave up fairly good employment in the United States in order to take chances of doing better here. A remarkable feature of this situation is that these men come from all parts of the United States. The last steamer brought laborers, on their own account, from Maine, New York, Tennessee, Illinois, Colorado, and California, and they have all been obliged either to go without employment or to take work in competition with Jamaican and other colored labor, which they will not be able to endure for any length of time.—John Barrett, Minister to Panama.

Calstonite.—A new product of the electric furnace has been introduced in France under the designation calstonite. It is a double carbide of barium and calcium, produced by M. J. Cartier, an electro-metallurgist of Mancioux, which decomposes on contact with water, like calcium carbide.

A 750-TON METAL MIXER.

Herewith we give an illustration of an interesting metal mixer which has recently been installed in the works of the Ebbw Vale Steel Company, of Great Britain. This mixer, which is of 750 tons capacity, is constructed upon the patents of Col. Charles Allen and Mr. Charles Davy, of Sheffield, and is the largest of its type that has been constructed, the average capacities ranging from 100 to 750 tons. The higher capacity for this particular installation, however, was rendered necessary to cope with the extensive additions to the steel plant that have been carried out at these works, and furthermore it is intended to serve as a reservoir for the week-end make.

The body of the mixer is constructed of a double thickness of steel plating and is carried at each end upon two circular massive steel rockers of box section. These rockers are machined on the underside, and rest on turned-steel rollers, 4 feet 6 inches in diameter, which are mounted on bearings on cast steel girders. The bottom of the mixer is further stiffened by a number of rolled-steel joists, 24 inches deep, so as to obviate any tendency that may develop to bulge owing to the weight of the metal within. The top is held together by four 6-inch tie-bolts. The ends are coned, the cones terminating in heavy cast-steel rings machined on the face.

Port ends are provided for gas-firing, by means of which the temperature of the metal within may be maintained. The port ends are mounted on wheels so that they can be easily moved back when required.

Two large hydraulic cylinders mounted on trunnions serve as a means for tilting the mixer. They are of sufficient stroke to empty the mixer completely when required, the pouring spout being on the opposite side.

The mixer is provided with an acid lining, and consequently no side doors are required. It is of much more substantial construction than is actually requisite for strength; but stiffness of structure very much favors the life of the lining, and the movement in tilting is found to be very smooth and free from vibration.

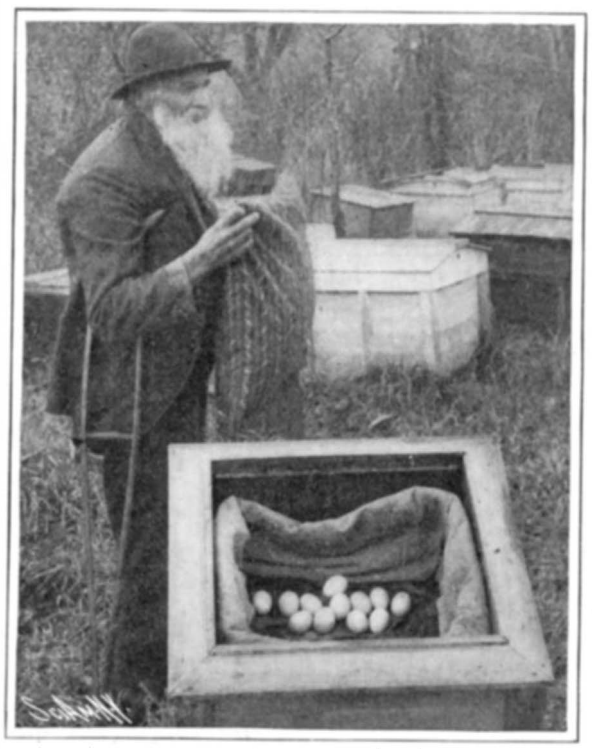
In any steel works having blast furnaces the use of a mixer greatly cheapens the manufacture of the steel, besides improving and equalizing its quality, and this type of gas-fired metal mixer possesses the convenience that the metal as received from the blast-furnace can be maintained in its molten condition for an indefinite period, the gas-firing being easily regulated to replace any lost heat or to increase the temperature if required.

For basic steel, doors are provided both on the sides of the body of the mixer and on the cone ends, so as to render the whole of the lining easily accessible for inspection and fettling. In some of the mixers of this type, moreover, an extra large door is provided for the purpose of charging heavy lumps of scrap. When such melting of scrap and deoxidizing is to be done in the mixer, the port ends are made larger than in the present case, thereby enabling the mixer to be worked at a higher temperature. In these instances the cone ends of the mixer and the port ends are provided with cooling-blocks, and the port ends are fitted with hydraulic drawback gear.

The earliest marine cylindrical boilers were single-ended with two furnaces, but with the advent of reliable mild steel the diameters were increased and the boiler was made double ended, with upper ends rounded to save bracing, so that the largest cylindrical boilers today have as many as eight furnaces, four in each end in pairs; that is, the two furnaces at each end on the same side of a vertical diameter have a common combustion chamber. The saving in weight is evident at once and also the reduction in the feeding apparatus required.

A BEEHIVE INCUBATOR.

Henry Decker, of Rome, O., by repeated tests has demonstrated that a setting of eggs may be successfully hatched within an ordinary beehive as the incubator. As more than a dozen eggs can be cared for at a time, it is claimed that one hive can be made to do



UTILIZING AN ORDINARY BEEHIVE AS AN INCUBATOR.

the work of eight hens, and also produce 100 pounds of honey annually.

Mr. Decker, who had previously used an incubator, one day while handling a swarm of bees observed that the temperature within the hive was similar to that of his incubator. His supposition was later verified by placing a thermometer in the hive, and comparing the temperature with that of the incubator. Thereupon he placed twenty eggs in the upper section of the hive, separating them from the working apartments of the bees by a cotton cloth. Around the sides a cushion made from a quilt was placed, and over the eggs another cushion. Eighteen of the twenty eggs were hatched.

Free Government Coal Tests.

An opportunity has been offered the coal producers of the country to co-operate with the United States Geological Survey in its work of testing the coals and lignites of the United States. This work was begun at the World's Fair grounds, St. Louis, during the Exposition and will be continued along the lines laid down at that time. The Survey is desirous of securing from operators and others interested in the problems of fuel consumption an expression of opinion as to whether they desire to co-operate in this work. Offers of coal for testing purposes should be addressed to the Director of the United States Geological Survey, Washington, D. C.

It is not possible to promise at the present time that all offers of coal will be accepted, but the plan is to make the investigation as complete as practicable, distributing the work as impartially as possible over the entire country. The distribution of the work will depend largely upon the replies received to the circular which the Survey is now sending out to coal operators and upon the present and possible future development of the coal and lignite deposits of several States.

The tests will be made for the purpose of determining the fuel values of the different coals and lignites and the most economical methods for their utilization. Arrangements have been made with the manufacturers of the equipment used during the Exposition to have practically all of this testing machinery left at the disposal of the government.

In offering coal for testing purposes, operators are requested to note the following conditions with which it is necessary to comply:

1. The coal must be furnished to the testing plant free of cost to the government.

2. The coal must be loaded under the supervision of one of the inspectors employed for that purpose, who shall be at the same time allowed to visit the working places in the mine to procure samples for analysis.

3. When it is possible to do so, the coal should be loaded in box cars and shipped under seal. Lignites must always be shipped in this way.

4. Where the market requires screened coal, this grade will be accepted for test. The selection of coal is always to be under the direct control of the representative of the testing plant.

5. Where one of the problems involved is the better utilization of slack coal, a carload of slack may be accepted for testing purposes.

6. As soon as possible after the tests are completed a brief statement of the results will be furnished to parties supplying the coal, for their information, but this must not be made public until the results are published by the Geological Survey.

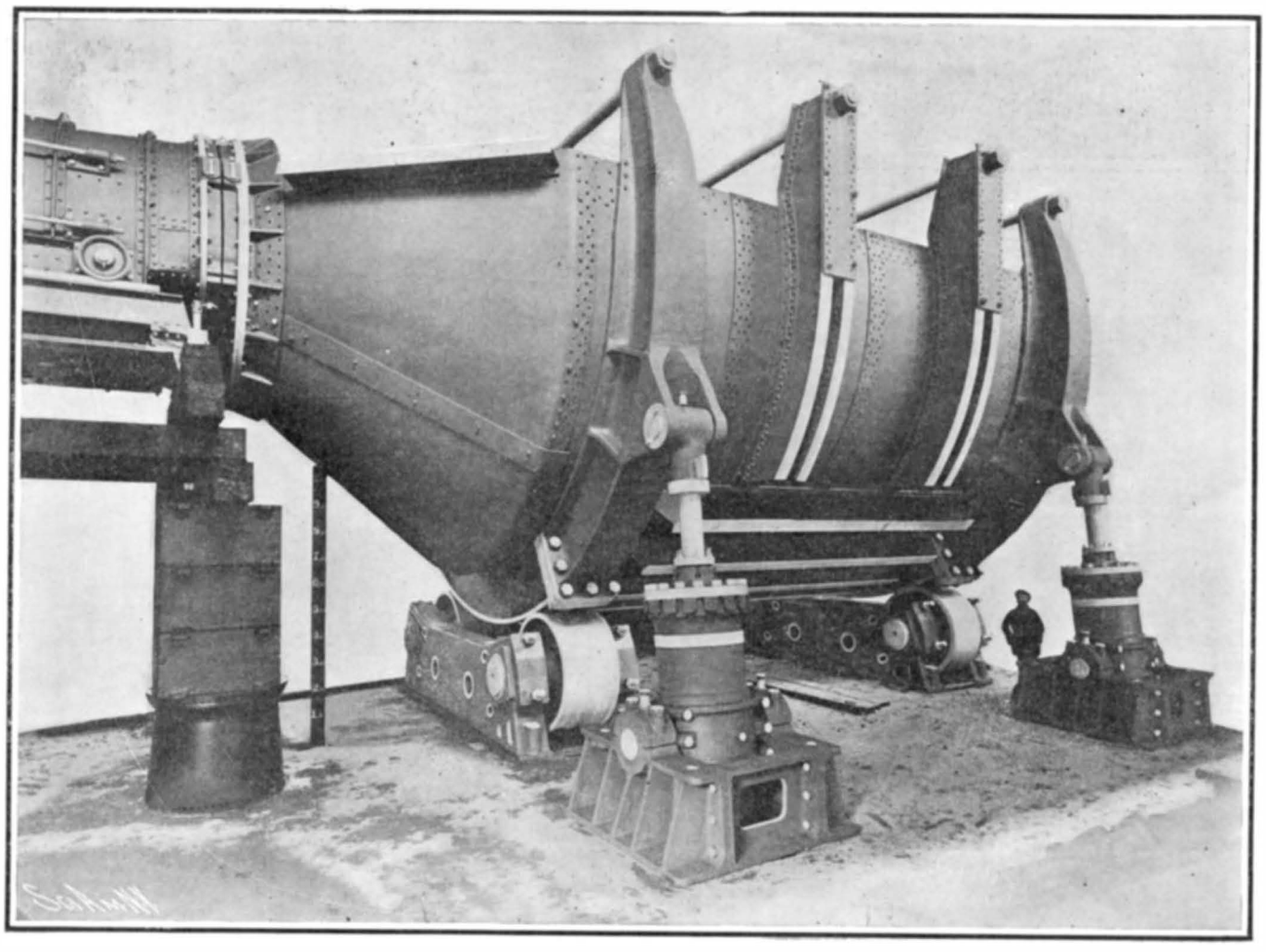
7. Everyone interested in any particular test or in the general operation of the plant is invited to be present at any time, but the official record of the test will not be given out except as indicated in the preceding paragraph.

Prizes for Inventors.

Under date of April 20, 1905, United States Consul-General Richard Guenther, of Frankfort, Germany, states that the Associazione degli Industriali d'Italia, No. 61 Foro Bonaparte, Milan, Italy, invites inventors to compete for two prizes offered by it, as follows:

First prize, $1,600 and a gold medal, for a new method to prevent danger which may arise from the contact of high tension with low tension winding of electric rotary-current transformers; second prize, $100 and a gold medal for a simple, strong, and reliable safety device for stopping cars running on an inclined plane in case of the breaking of the wire cable. The device must be capable of adjustment to ordinary cable roads now in use.

In experiments made by Jeantaud with an electric motor car a tractive effort of 42.7 pounds per ton at 10.8 miles per hour was observed on a dry road. On a muddy road the tractive effort rose to 74 pounds per ton at 9.32 miles per hour. Thus the resistance on a dry road is found to be forty-three and three-tenths per cent less than that developed on a muddy road.



A 750-TON METAL MIXER.

RECENTLY PATENTED INVENTIONS.

Electrical Devices.

COMBINATION GAS AND ELECTRIC FIXTURE.—C. S. STEINBERG, New York, N. Y. Mr. Steinberg's invention relates to improvements in fixtures of that class wherein a gas pipe and electric light wires are both housed or incased within a suitable envelop or external casing. In the present case he has in view the production of a combination fixture wherein the formation of a short circuit between the electric conductors and the gas pipe is a practical impossibility under the ordinary condition of service and also to provide means for easily and quickly rewiring the fixture without removing it from its place of installation on wall or ceiling.

Of General Interest.

CLASP OR FASTENER.—A. DE SAINT CHAMAS, Chicago, Ill. The object of the invention is to provide a clasp for conveniently and securely closing or sealing envelops, wrappers, and like means for permitting postal authorities or other persons to quickly open the envelop, wrapper, or other receptacle for examining contents thereof without detaching the clasp from the receptacle. The improvement relates to envelop-clasps such as shown and described in the Letters Patent of the United States formerly granted to this inventor.

BLANK-CARTRIDGE CANNON. — M. J. SHIMER, Freemansburg, Pa. One purpose in this improvement is to provide a toy cannon having its breech adapted to receive cartridges and to provide a hammer having a cup-shaped head which when it strikes the cartridge-shell to explode a cartridge fully covers the breech, thus preventing the possibility of fragments of the shell escaping should the shell be unduly fractured at firing. Means especially adapted to be operated by the foot when the hammer is to be released for firing, prevent danger of accidents to face and hands of the gunner.

Heating and Lighting.

CRUDE-OIL BURNER.—J. W. PIPPIN, Brownwood, Texas. Having several objects, one of this inventor is to provide a novel construction which may be utilized in kitchen-stoves or in fireplaces, furnaces, or other locations and by the use of which smoke, soot, and the like may in a large measure be avoided and the oil and water vapor will be supplied under proper control.

Machines and Mechanical Devices.

ATTACHMENT FOR SURFACING-MACHINES.—W. C. AVERILL, Frankfort, Maine. The special object is to enable the tool to be guided so as to strike the stone exactly on the desired spot and also to be turned so as to dispose the edge of the tool, and consequently the cut thereof, in any position with respect to edges of the stone. It is attained by providing a peculiar guide connected with a shiftable part of the finishing-machine, this part movably carrying the tool. Means are provided enabling movement of a handle independently of a guide to impart to the tool an independent movement.

SEWING-MACHINE.—J. A. VIGLINI, Louisville, Ky. The aim in this improvement is to provide means for holding goods against feeding action, which shall be operative without stopping the machine and whereby the thread may be effectively locked. While designed as an attachment to automatic chain-stitch sewing-machines, its broad conception would comprehend use with any machine to which it is adapted by obvious modification.

Prime Movers and Their Accessories.

FLUE-PLUG.—P. J. MALLOY, Shreveport, La. Mr. Malloy's object is to provide a plug for closing a flue when desired and having means for covering the end of the flue so in case of bad leaks it will cover the entire bead of the flue and if the plug leaks the water will be turned downward along the flue-sheet instead of spraying out over the fire. The plug has a decided advantage over the old style of plugs in getting it out of the flue sheet by having a square head on it, saving time in getting it out of the flue sheet without damaging flue or sheet.

ROTARY ENGINE.—L. T. STEWART, South Plymouth, N. Y. In this instance the object is to provide a rotary engine arranged to utilize the motive agent economically and to the fullest extent, to automatically cut off the motive agent according to the load, to allow running the engine at a high rate of speed and without undue vibration or noise, and to reduce wear and leakage to a minimum.

Railways and Their Accessories.

RAIL-TIE.—E. POWELL, Columbus, Ohio. The principal objects of the invention are to provide means secured in the tie for effectively holding the rail, for preventing the swinging of the rail on the tie, or *vice versa*, for strengthening the tie, and at the same time for permitting the tie to be readily placed in the road-bed.

NOTE.—Copies of any of these patents will be furnished by Munn & Co. for ten cents each. Please state the name of the patentee, title of the invention, and date of this paper.

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The distinction between the bonds and the usual five year mortgage is simply that instead of using a trust deed and one single principal note, with interest notes attached, representing the whole amount of the loan, a trust deed is used in the regular way, but the principal note is divided into a number of small notes, say of $100 and $500 each, aggregating the amount of the indebtedness, and each one of these notes (or first mortgage bonds, as we term them, because they have taken the form of bonds) has its interest notes attached, and each one, with the others, is a first mortgage on the property, and each bears the certificate of the trustee certifying that it is a first lien on the property described.

A Few Samples of Properties on Which Loans Have Been Made and Bonds Sold by the Jennings Real Estate Loan Co.

You will notice the following desirable features in every bond issued by this Company:

1. It is secured by the specific real estate described in the bond, and is not a portion of a "blanket mortgage" upon different and separate pieces of real estate, or issued against the credit of any corporation or individual. The investor can, if he likes, visit, examine, and appraise his own security and *know* precisely what is back of the bond in which he is investing his money. This removes every possible element of guess-work or speculation from the transaction.

2. The Chicago Title & Trust Company (capital $5,000,000) identifies each bond by its certificate and guarantees it to be a first mortgage on the property.

3. Before the loan is made each piece of real estate is valued by our Mr. Jennings, one of the most experienced real estate appraisers in the West.

4 The fire insurance upon the improvements is always more than the amount of the loan.

5. The income in rentals is always four to five times the amount of the interest on the mortgage.

6. Each bond is a separate unit which may be sold, or pledged as collateral in borrowing money, just the same as a government, state, city, or railroad bond.

7. The Jennings Real Estate Loan Company collects and remits the semi-annual interest coupons for its customers, without charge.

8. Each bond carries six per cent interest, giving, for the first time, the man with $100 the same return upon his money and upon precisely the same security as though his investment were $100,000.

We want every careful and conservative investor who reads this advertisement to get into communication with us.

If the investor lives in Chicago and has $100, $200, $500 or $1,000 in some good savings bank paying only three per cent, we cordially invite him to come to our offices and make the personal acquaintance of our Mr. Jennings and the other officers of the company. Our offices are conveniently located, being in the new First National Bank Building, which is the center of the financial district of Chicago.

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READ THIS COLUMN CAREFULLY.—You will find inquiries for certain classes of articles numbered in consecutive order. If you manufacture these goods write us at once and we will send you the name and address of the party desiring the information. **In every case it is necessary to give the number of the inquiry.**

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Inquiry No. 6937.—For manufacturers and builders of iron and steel structures.

Commercially pure nickel tube, manufactured by The Standard Welding Co., Cleveland, O.

Inquiry No. 6938.—For manufacturers of machines for extracting salt from brine.

Sawmill machinery and outfits manufactured by the Lane Mfg. Co., Box 13, Montpelier, Vt.

Inquiry No. 6939.—For manufacturers of patent fuel and briquette machinery.

I sell patents. To buy them on anything, or having one to sell, write Chas. A. Scott, 719 Mutual Life Building, Buffalo, N. Y.

Inquiry No. 6940.—For manufacturers of railroad velocipede cars.

WANTED.—The names of manufacturers of novelties wishing a representative. J. Berkeley Hunter. Box 1629, Pittsburg, Pa.

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The celebrated "Hornsby-Akroyd" Patent Safety Oil Engine is built by the De La Vergne Machine Company, Foot of East 138th Street, New York.

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Gut strings for Lawn Tennis, Musical Instruments, and other purposes made by P. F. Turner, 46th Street and Packers Avenue, Chicago, Ill.

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Manufacturers of all kinds sheet metal goods. Vending, gum and chocolate, matches, cigars and cigarettes, amusement machines, made of pressed steel. Send samples. N. Y. Dieand Model Works, 508 Pearl St., N.Y.

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You can rent a well equipped private laboratory by day, week or month from Electrical Testing Laboratories. 548 East 80th Street, New York. Absolute privacy. Ask for terms and facilities.

Inquiry No. 6945.—For manufacturers of dies for cutting teeth on gin saws.

Manufacturers of patent articles, dies, metal stamping, screw machine work, hardware specialties, wood fiber machinery and tools. Quadriga Manufacturing Company, 18 South Canal Street, Chicago.

Inquiry No. 6946.—For manufacturers of strong rope wrapping paper.

Space with power, heat, light and machinery, if desired, in a large New England manufacturing concern, having more room than is necessary for their business. Address Box No. 407, Providence, R. I.

Inquiry No. 6947.—For manufacturers of machinery for cocoanut and oil-making plants.

WANTED.—The patents or sole agency for Britain and France, of new machines and articles used in the Brewing and Allied Trades. Highest references given and required. State best terms with full particulars to "Wideawake," care of Streets Agency, 30 Cornhill, London, England.

Inquiry No. 6948.—For manufacturers of machinery for extracting and carding cocoa fibers.

WANTED.—A first-class Machine Shop Foreman; a man who is capable of producing work at the lowest possible cost. Must be a man of ideas and capable of hiring and handling men. Reliability first consideration. Steady position with opportunity to advance. Factory at Waterloo, Iowa. Address Manufacturer. Box 773, New York.

Inquiry No. 6949.—For manufacturers of machinery for a tapioca plant.

AGENCIES FOR NEW ZEALAND.—Poultry Breeding Fruit Growing and Canning Industries being pushed by the Government of New Zealand. Competent experts now starting as horticultural merchants are desirous to become New Zealand representatives for implements and machinery, etc. Address Hugh Gerard, Parapararaumu, Wellington, New Zealand.

Inquiry No. 6950.—For firms in United States manufacturing apparatus for the dry distillation of wood, for producing alcohol, charcoal and other products.

Splendid opening for a high-grade mechanical engineer, who has had a broad experience in managing machine shops, the manufacture of machinery, engines and metal specialties. Applicants must be in prime of life and now employed. Preference will be given to applicants who have had modern scientific training in mechanical schools of high standing. Unqualified references will be exacted. All communications received will be regarded as strictly confidential. Address Mechanical Engineer, Box 773, New York.

Inquiry No. 6951.—For manufacturers of fire clay articles.

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Is the title of a clever little love story published by the LACKAWANNA RAILROAD solely on its merits as a bright piece of fiction. It is contained in a beautifully illustrated book of one hundred and twenty-eight pages which describes some of the attractive vacation places along the lines of that road.

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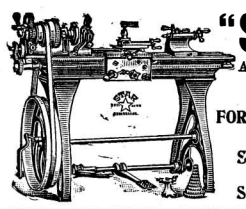
Inquiry No. 6952.—Wanted, address of F. Keil & Son, manufacturers of cabinet hardware.

Inquiry No. 6953.—For manufacturers of diamond doublets.

Inquiry No. 6954.—Wanted, a second-hand automatic turning lathe, suitable or turning table legs.

Inquiry No. 6955.—For manufacturers of an article called "helps to hear" or ear drums.



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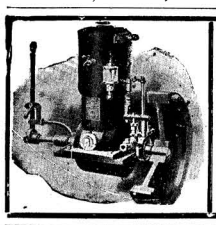

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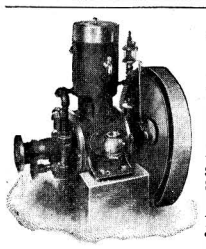

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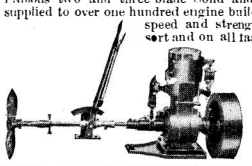

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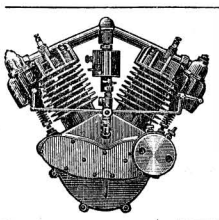

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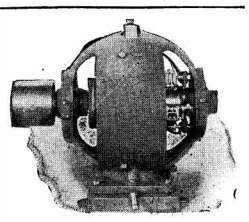

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HINTS TO CORRESPONDENTS.

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Minerals sent for examination should be distinctly marked or labeled.

(9659) A. E. R. asks: Can you refer me to an article on the construction of cement or pebble wash siding for houses over steel lath? I buy your Builders' Monthly and also the SUPPLEMENT, but never remember reading anything on this subject. A. We are sorry that we have no article which we can send you describing the construction of cement or pebble work siding for houses. This work is done by first securely fastening a stout wire lath over the portion of the house which it is desired to treat in this way. Sufficient space should be left between the lath and the sheathing of the house to permit the mortar to be worked through and get a good hold. Cement mortar is then put on the lath in the same way that ordinary plastering is applied, being always careful to work it through the lath in order to get a good hold. The mortar used for this purpose is one part of best Portland cement and three parts of clean sharp sand, thoroughly mixed and tempered with water, to which a small percentage of lime putty may be added to make the mortar work more freely. The less lime that is used, however, the better. After a thick layer of mortar has been applied in the manner above described, pebbles, stones, or other articles may be inserted, but care should be taken to see that they are embedded sufficiently deep for the mortar to get a good hold on them.

(9660) J. S. W. asks: Will you kindly tell me which is the most accurate way to determine the horse-power of a steam engine with a brake or indicator? Best make of brake, and how applied. Also best-known cylinder lubricant for steam engines, condensing and non-condensing. Does hydrocarbon, in any form, possess lubricating qualities of any value for cylinders of steam engines? A. First, the brake and indicated horse-power of an engine represent two different things. The first gives the power which the engine is capable of delivering to a generator or line shaft. The second gives the power which the steam generates inside the cylinder of the engine. The brake horse-power is less than the indicated horse-power by an amount equal to the entire friction of the engine. One, however, is as accurate as the other, but, as we have explained, they are measurements of different quantities. The simplest form of brake applied to an engine is a rope brake, consisting of a heavy manila rope, wrapped a number of times around a flywheel in such a way that one end may be tightened with a screw and handwheel, and the pull on the other end weighted in some simple way. All the lubricating oils are composed of various hydrocarbons, but their lubricating power depends upon their physical properties, not their chemical. The important thing in a cylinder oil is to have one which will retain its lubricating qualities at the temperature of the steam in the cylinder.

(9661) E. W. P. says: Will you please tell me which, if either, of your reference books will tell me all about fuses—what metals are used to fuse or melt at 125 to 160 degrees of heat? If this is not in one of these books, will you answer either by letter or in the columns of your valuable journal? A. An alloy consisting of 1 part lead, 1 part tin, 4 parts bismuth, 1 part cadmium, will melt at 155 deg. Fahr.

(9662) A. H. N. says: If soft coal ashes be mixed with water to the consistency of mortar and then put in a round oak or other soft coal heater on a good bed of coals and the drafts opened, this mixture will burn freely. How do you explain this anomaly? A. There is always a considerable percentage of unconsumed fuel or combustible in ashes—especially soft coal ashes—even though they may appear to be free from coal; so that they will have a certain amount of fuel wherever they can be burned without clogging up a fire and choking the draft. The addition of a moderate quantity of water to a hot soft coal fire has a curious effect. If the temperature is sufficiently high, the water is decomposed, forming free oxygen and hydrogen, which later reunite at a point usually some distance above the body of the fire in a hot flame. No heat is actually added to the fire, the effect being to abstract the heat from the coals and give back the same quantity of heat in flame above the fire, oftentimes giving the appearance, however, of making a hotter fire. In cases where a long

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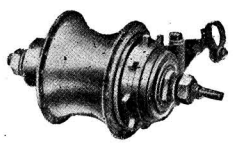

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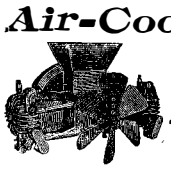

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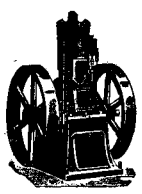

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flame is desirable, as in fire under a steam boiler, it is a common practice to wet the coal before firing it, for this reason. These facts will probably help you to explain the phenomenon you have observed.

(9663) W. G. M. asks: Will you please inform me through your Notes and Queries whether putting zinc in a stove affects in any way the formation of creosote in the chimney; if so, what is the theory? It is popularly said here that the zinc will prevent the evil. A. If zinc is put in a hot stove it will burn, forming dense clouds of a white powder, called zinc oxide. This could have no chemical effect on any other formation in the chimney, but it is not impossible that this white powder might prevent other substances from sticking to the walls of the chimney as readily as they otherwise would.

NEW BOOKS, ETC.

THE SECRET OF THE CIRCLE AND THE SQUARE. By J. C. Willmon. Los Angeles: The McBride Press, 1905. 12mo.; pp. 30.

In this small book the author endeavors to demonstrate the possibility of constructing a straight line equal to any given arc of a circle, and also of constructing a square equal in area to any circle, and *vice versa*, together with solutions of similar geometrical problems. Another attempted demonstration is the division of angles into any number of equal parts. The book is illustrated with eight geometrical figures, and the problems to be solved are clearly and concisely stated.

THE SPINNING AND TWISTING OF LONG VEGETABLE FIBERS. By Herbert R. Carter. Philadelphia: J. B. Lippincott Company, 1904. 8vo.; pp. 360; 161 illustrations. Price, $5.

This book is a practical guide for the technical student and man engaged in the business, to the spinning of the long vegetable fibers, such as flax, hemp, jute, tow, and ramie. The same general principles underlie the preparing and spinning of all these long vegetable fibers, and so it is merely the details of the various processes which differ somewhat on account of the coarseness or special nature of the different fibers. The various different machines for spinning such fibers are described in detail in the present volume, and a thorough description of the most modern methods applied to the hackling, carding, preparing, spinning, and twisting of them is given.

REFUSE DISPOSAL AND POWER PRODUCTION. By W. F. Goodrich. New York: E. P. Dutton & Co., 1905. 8vo.; pp. 384. Price, $5 net.

The sanitary destruction of garbage is one of the great problems of all large cities. The author of the present volume has gone into this subject very thoroughly, and, after describing the usual methods of disposing of refuse by dumping it at sea or on land, he goes into the modern and more scientific methods of disposal by burning it under a steam boiler for power-generation purposes. Some model electric lighting plants deriving their power from garbage are illustrated and described. All the very latest information on this important subject is given with complete figures. The book will be found very useful by all who have to do with the problem of garbage disposal on a large scale.

LES DECHETS INDUSTRIELS. RÉCUPÉRATION —UTILISATION. By Paul Razous. Paris: Vve. Ch. Dunod, 1905. 8vo.; pp. 379. Price, $4.20.

Much progress has been made in the last few years in the utilization of the waste products and residues of large industrial plants. In the present volume, M. Razous has shown this progress, and indicated what may be done with waste products in various industries. He first describes the waste products of usual power plants, that is to say, those products which result from the production of motive power, from oiling, from wiping and cleaning the engines, from the modes of lighting adopted, etc. He afterward describes the nature of the waste products and residues obtained in the various industries, and indicates the methods of utilizing them, and the processes by which sub-products of a value greater than the cost of obtaining them may be derived.

INDEX OF INVENTIONS

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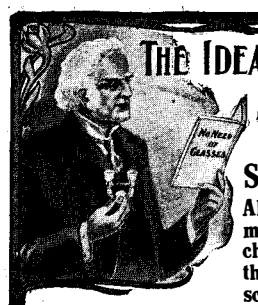

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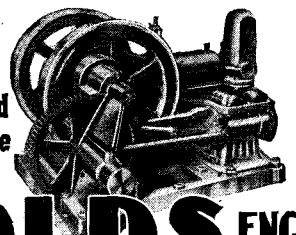
The Wizard Engine  **With Pump**
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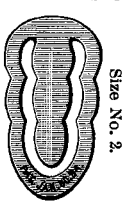

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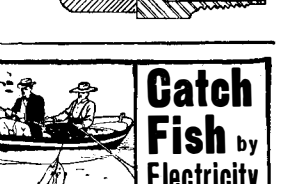

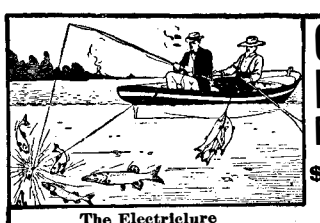

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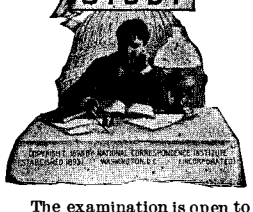

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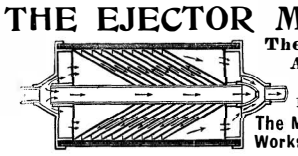

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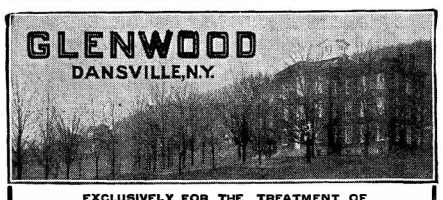

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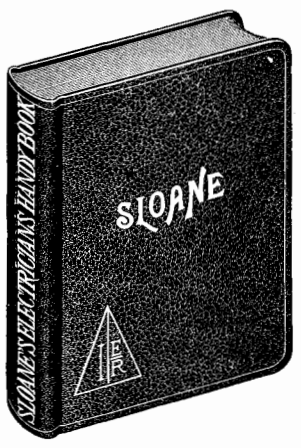

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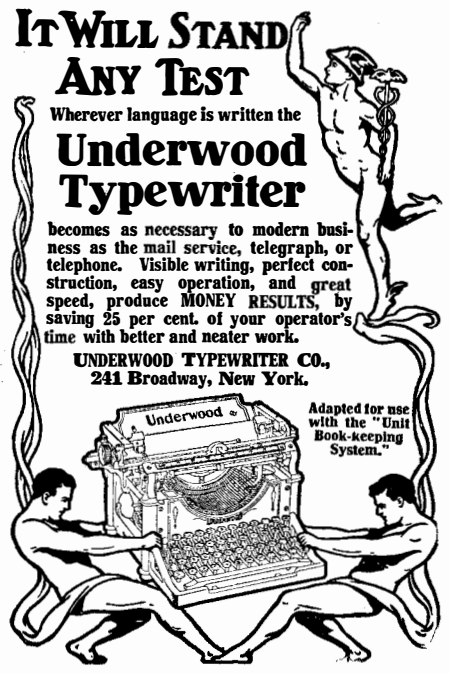

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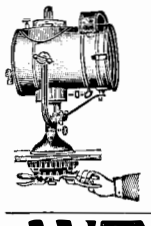

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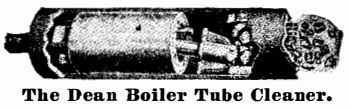

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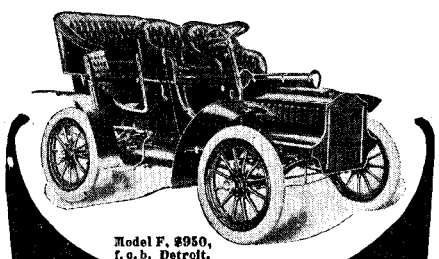

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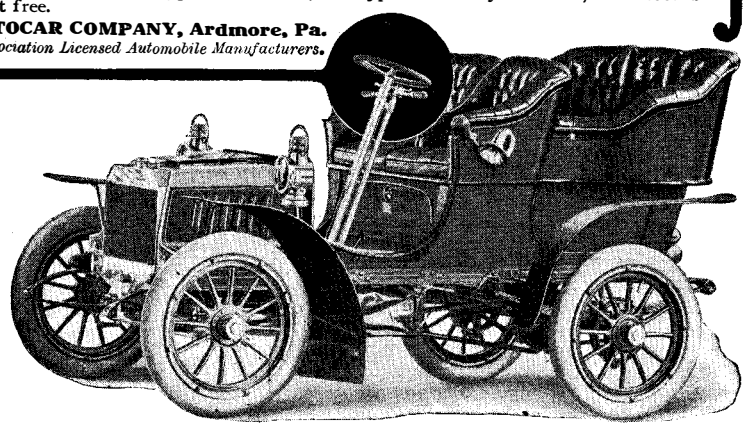

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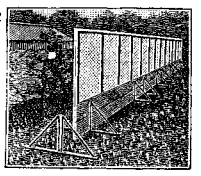

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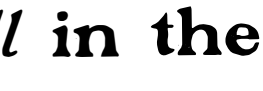

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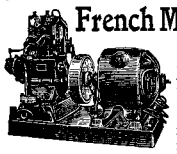

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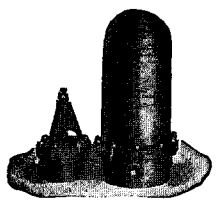

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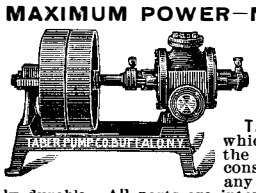

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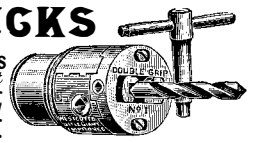

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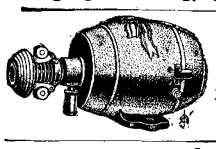

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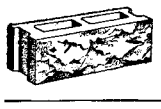

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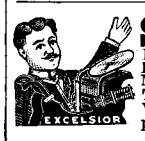

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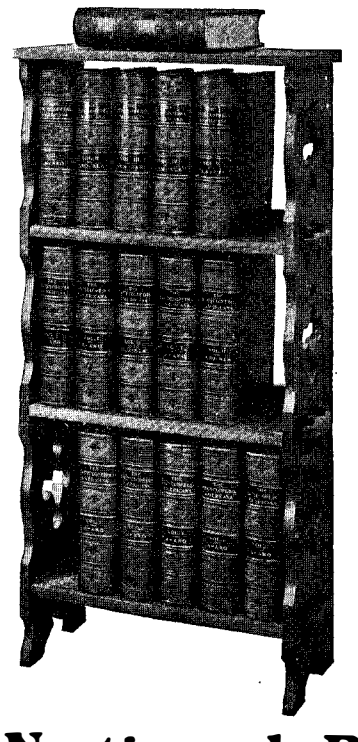

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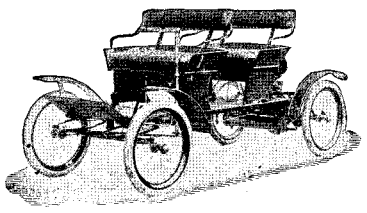

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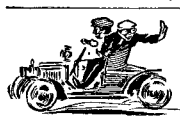

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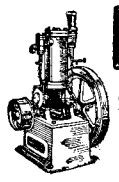

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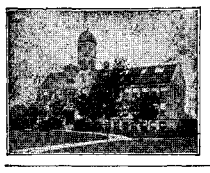

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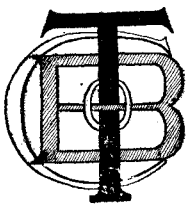

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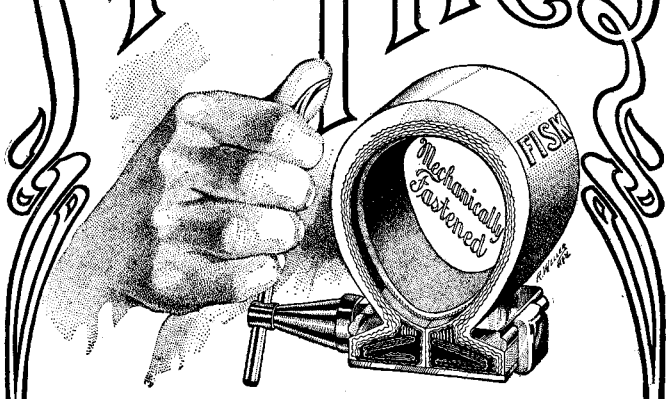

SECURELY LOCKED TO RIM!
INSURING POSITIVE SAFETY

It is their Exclusive Features which have given FISK TIRES world-wide celebrity. These points of advantage, combined with Durability (insured by the finest quality and workmanship) have caused its enthusiastic endorsement by everyone of experience. : : :

Note the Air Space—It's all above the rim!

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Rapid Mechanical Calculation

The New Model Comptometer solves any business or scientific calculation instantly and noiselessly. It has a light, uniform key touch, and adds instantly at one stroke as many keys in separate columns as the hand can reach.

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The Watres Gas Engine Whistle

is an innovation for marine motoring. It is operated simply by spent gas and does not affect the running of the engine. Whistle blown by the touch of a cord at engineer's elbow. Blows simultaneously three tones of chromatic scale and can be clearly heard two miles away. Does away with all hand pumping. The device is simple, easily attached and has nothing to get out of order. It is absolutely safe and satisfactory. Thirty days' trial allowed, then, if not satisfactory, say so, and back goes your $35. Booklet on request.

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Complete Only $15.

BURNS WOOD or COAL

JUST SEND ME ONE DOLLAR

and I will ship C. O. D. to any railroad station in the U. S. this fine Willard Steel Range Anyone can say they have the best range in the world, but I will furnish the evidence and leave the verdict to you. After you examine this range, if you are satisfied in every way, pay Agent $14.00 and freight, and you become the possessor of the best range in the world for the money. The range has six 8-inch lids; 18-inch oven; 15-gallon reservoir; large warming closet; top cooking service 30x34 ins. Guaranteed to reach you in perfect order. Shipping weight, 400 lbs. Thousands in use and every one of them giving satisfaction. Write for full description and testimonials.

WM. G. WILLARD
No. 12 WILLARD BUILDING
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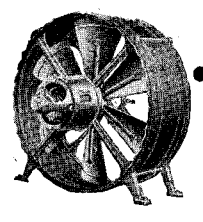
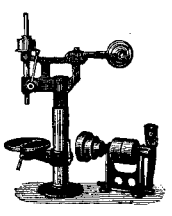


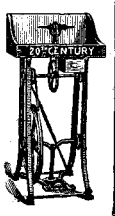
WE GUARANTEE

OUR OUTFITS TO HANDLE MORE AIR FOR THE POWER CONSUMED THAN ANY OTHER SET OF THE SAME SIZE. TO BUY THEM IS GOOD **ECONOMY.** GENERATORS, VARIABLE & CONSTANT SPEED MOTORS

Rochester Electric Motor Co., 10-12 Frank Street, ROCHESTER, N. Y.



The Modern Machines for Mechanics



Here are two of the most useful and indispensable machines. The cut on the left shows the best Bench Drill ever constructed for sensitive work. Drills from smallest size up to 5-16 inch. Spindle has Morse No. 1 taper hole and is counterbalanced by coil spring around feed lever shaft. Insures perfectly true and accurate work. The Twentieth Century Polishing Lathe, see cut on right, is one of many different styles and sizes of Polishing Lathes that we manufacture. We have them to run by foot or belt power, for use in all mechanic's lines. Send for catalogues B-15, C-15.

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Special Offer

Talks Plays Sings

"HIS MASTER'S VOICE"

FREE TRIAL

AT YOUR HOME

Special Offer to Readers of

Scientific American

To any reputable business man, honest mechanic, machinist or other person who will assure us of his responsibility, we will ship our **Victor** Royal Talking Machine and your choice of one dozen **Victor** Records (lowest net cash price everywhere **$20**) on free trial.

If after 48 hours' free trial **at your home** you are not satisfied with the instrument, return it at our expense and we refund in full whatever you may have paid us. **We charge you nothing for the trial.** If satisfactory send **$5** after the trial at your home, balance of **$15** being payable **in six months'** installments of

$2.50 A MONTH

Don't confuse this with toy machines offered at ridiculous prices. The **Victor** has an oak cabinet, spring motor, may be wound while playing and will play any disc record. Anybody can play it; the greatest concert pieces, songs, comic recitations, etc.

This is the genuine **Victor** Talking Machine, and you cannot buy this outfit for spot cash anywhere for one cent less than **$20,** the established price. **Buy direct from us,** and get it just as cheap on monthly payments.

PLEASE NOTE **No lease or chattel mortgages; no guarantee from third parties. We trust any responsible party to pay as agreed.**

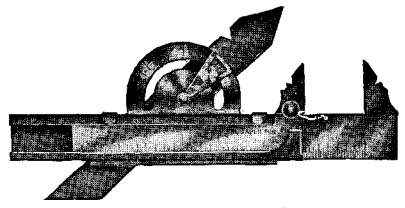
Don't you want to hear it talk, laugh, sing and play and give concerts in your home?

Catalog and List of 2000 Records Free

THE TALKING MACHINE CO.
Dept. 20 S, 107 Madison St., Chicago, Ill.

FREE to those who already own a **Victor:** 25 new **soft-tone,** non-scratching needles.

AGENTS WANTED



WE want a live man in every town in the country to act as our official agent in securing subscribers to MODERN MACHINERY. :: The work can be carried on nicely without interfering with your present occupation and it's an easy way to make a little money on the side.

MODERN MACHINERY PUB. CO.
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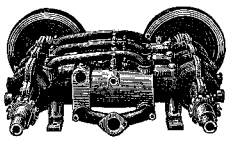
The Most Modern Marine Motor



having the most rapid speed and weighing least per h. p. and possessing the fewest parts is the **Van Auken Motor.** No vibration, easy to operate, simple, reliable, clean. Great power. Perfect control. Always ready. Every stroke cleans the cylinder.

VAN AUKEN-CLEVAUC CO.
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One of the greatest sanitary inventions of the age. Endorsed by forty Health Boards throughout the United States.

Dust, Moisture and Germ Proof
Price 50 cents. Postpaid.

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